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July 20, 1933

Engineering News-Record

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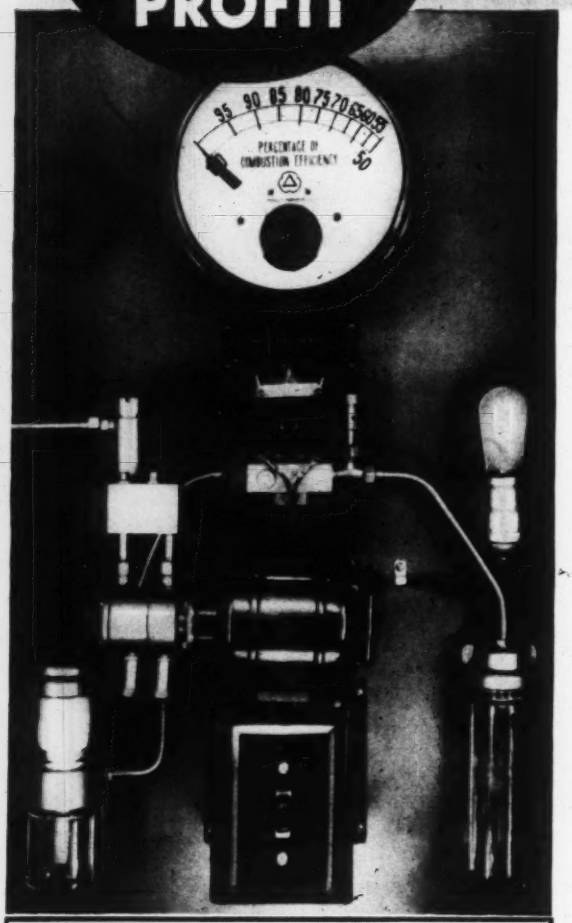

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Redesign and Construction of Prettyboy Dam

Rotten rock disclosed during construction of new concrete dam for water supply of city of Baltimore, Md., called for enlargement of structure and change in construction method

LATE IN 1930 Baltimore awarded a contract for the construction of Prettyboy Dam to provide a water-storage reservoir on the upper reaches of Gunpowder Falls 29 miles northwest of the city. The original contract, amounting to $997,000, contemplated the building in two years' time of a high gravity-type dam containing 109,600 cu.yd. of concrete and requiring 71,000 cu.yd. of excavation. Unforeseen poor rock conditions that were revealed after work had started required altering the original design of the structure and greatly increased the contract quantities. Excavation was increased almost six-fold to 410,800 cu.yd., and the concrete required was nearly double that of the original design, totaling 192,500 cu.yd. In the face of resulting delays and vast extension of work, the contractor finished the work in a little over six months beyond the time specified in the contract. The ultimate contract payment on the project was approximately $2,385,000.

Early in the progress of the work, when it became apparent that the excavation quantities would heavily overrun, the contractor built concrete ramps on both sides of the valley for disposing of excavated materials. In the original concreting plant the concrete was distributed by means of belt conveyors operating between tubular-steel towers. This method of disposition was later replaced by a system employing a timber trestle across the valley and traveling and stationary derricks, which placed the concrete with buckets.

In what is believed to be the first installation of the kind on construction work, wire saws were used to cut the trench for the cut-off wall under the heel of the dam. Linedrilling and broaching was also used in cutting out the trench.

Fig. 1—Prettyboy Dam, on the upper reaches of Gunpowder Falls, will provide additional storage for Baltimore's water-supply system. This air view shows dam nearly completed, part of cleared reservoir site and one of the concrete ramps up which excavation was hauled for disposal along roadway.

McLaughlin Aerial Surveys

Original design

Prettyboy Dam is located on Gunpowder Falls near the mouth of Prettyboy Creek, about 15 miles above the headwaters of the present water-supply development at Loch Raven. The Loch

Raven Reservoir, due to increased demand, had insufficient storage capacity to carry the city through a long period of drought. Water stored at Prettyboy will be released into the Gunpowder as needed at Loch Raven.

The original plans (Fig. 2) called for a concrete gravity-type dam 692 ft. long and 147 ft. (not including the cutoff wall) in maximum height from foundation to overflow crest. A 20-ft. roadway and two 4-ft. sidewalks crossed the dam. Of the total length, 400 ft. was planned to be overflow section, divided into eight 50-ft. lengths separated by the piers carrying the arches for supporting the roadway. A concrete cutoff wall 6 ft. wide and varying from 10 to 15 ft. in depth was planned to run under the heel of the dam for its full length. The dam foundation and downstream apron were to be level for a width of 150 ft. across the floor of the valley, then were to follow up the sides of the valley in a series of twelve steps on both sides of the valley about 10 ft. high and 14 ft. in width.

Revised design

Actual excavation of the hillsides revealed rock conditions not disclosed by the preliminary small-diameter core borings. The rock immediately underlying the loam and clay overburden, on both sides of the valley, was found to be a badly shattered mica schist full of seams and joint planes, which necessitated its removal to considerable distances and depths outside the originally planned lines. On the west side of the valley the rock encountered in excavating for the west 150 ft. of the area was found to be a badly ironized mica schist that deteriorated to a noticeable extent as soon as exposed to the air. Excavation was therefore stopped pending further examination. Four 36-in. calyx drill holes, one of which penetrated to a depth of 57 ft., were put down in the latter area to permit the consulting geologist to make a close inspection of the rock formation. His report indicated that sound rock would be found at the extreme western end of the dam, as then planned, at a depth of approximately 110 ft. below the plan grade.

The design of the dam was altered. The foundation of the entire structure was carried down through the shattered rock zone to sound rock, and the originally planned series of small steps (Fig. 2) was done away with, being replaced by one wide step on each side of the central stilling pool. At the west end the gravity section was shortened 10 ft. and was further supplemented by a short concrete transition section and a concrete corewall extending for an additional 163 ft. into the side hill. The corewall varies in width from 4 ft. at the top to a maximum of 12 ft. 8 in. at the bottom, and is 119 ft. in maximum height.

Because of the condition of the rock at the west end of the structure, extensive slides occurred in the sides of the cut, and a large amount of additional excavation was required to produce safe working conditions for corewall construction. This excavation is being replaced by rolled-earth fills, and that on the upstream side is being built up of a fine plastic red clay hauled about 18 miles to the site. The cutoff wall along the heel of the dam was retained in the revised design of foundations throughout the entire length of the structure, including the corewall, the extreme west end of which constitutes a water cutoff projecting into the weathered rock overlying the sound rock.

The other important alterations in design concerned the overflow section. To keep the overflow away from the high vertical cliffs on both sides of the valley, the length of overflow section was shortened, the eight original 50-ft. spillway sections being replaced by four 68½-ft. sections, and the clearance under the arch rings being increased 18 in. to maintain the necessary discharge capacity. The gravity section was decreased to 682 ft. in length, making the total length, including the corewall and transition section, 845 ft. Concrete aprons, similar to those originally planned, extend to the front of the overflow section for a distance of 215 ft. downstream from the upstream face. As the central portion of the apron is below natural streambed, a cushion pool 8 ft. in depth is formed.

The original plans for controlled discharge through the dam were kept, though the discharge works were raised 1½ ft. and shifted slightly toward the easterly end to accommodate the revised spillway section. The discharge works are contained in a non-overflow section 38 ft. wide set in the middle of the four spillway sections. The discharge will be through either of two 45-in. pipe lines, controlled by 36-in. needle valves at the outlets, located at El. 421.5. (Crest elevation is 520; tailwater elevation, 387.) A gate house built on the upstream side

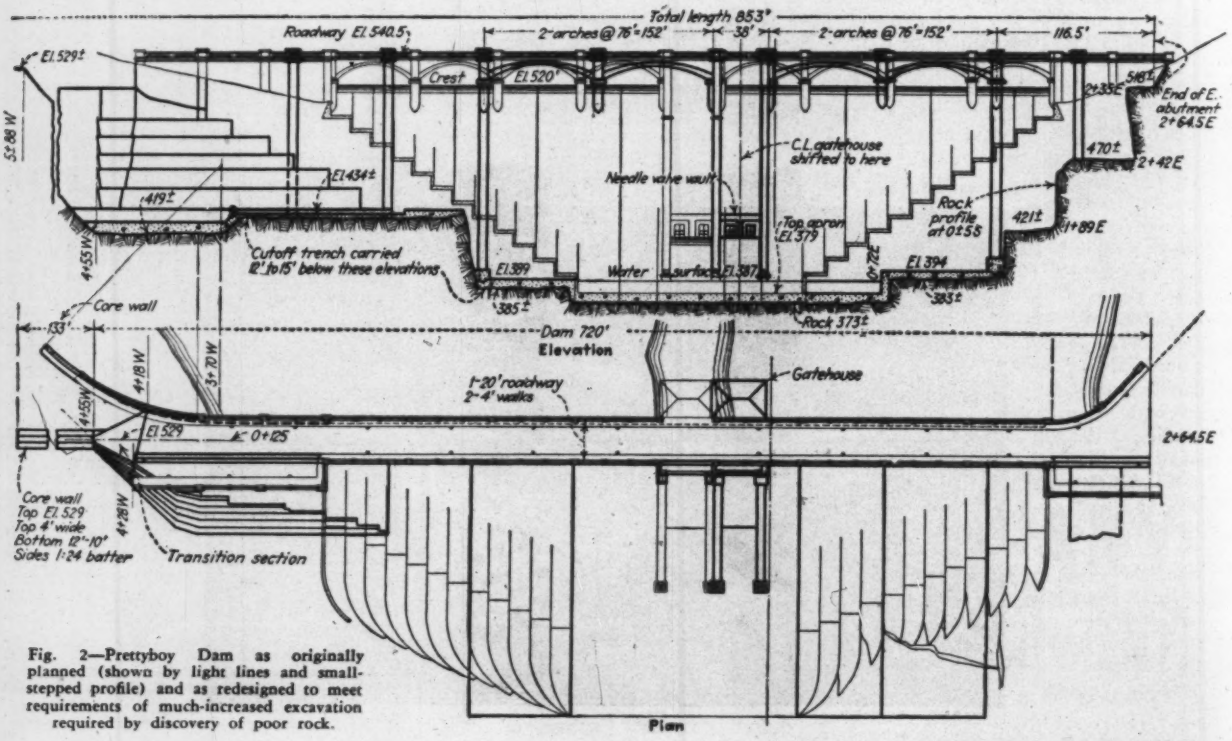


Fig. 2—Prettyboy Dam as originally planned (shown by light lines and small-stepped profile) and as redesigned to meet requirements of much-increased excavation required by discovery of poor rock.

adjacent to the central non-overflow section contains eight 36x60-in. sluice gates, set at three different levels, which will control the flow into two 6x9-ft. wells into which the 54-in. discharge pipes are connected. As an additional control, each 54-in. line contains a 36-in. cone valve.

The specifications for concrete called for four separate sizes of coarse aggregates, including cobbles passing a 9-in. square screen. To provide for possible insufficiency in fine particles in the available sand, the use of stone screenings was also provided for if needed. All aggregates were proportioned by volume, although the sand and at times part of the crushed stone volume were controlled by weighing. Class A concrete, specified at 3,000 lb. in 28 days and containing only the small stone aggregate was used in the upper part of the gatehouse, the abutment curtain walls, the highway bridge and in miscellaneous reinforced work. Class B concrete (2,500 lb.), using small and intermediate sizes of stone, was specified for the upstream 4 ft. and the downstream 2 ft. of the mass concrete in the dam. Class C concrete (1,500 lb.), containing small, intermediate and large stone aggregate, plus cobbles, makes up the main mass of the dam between the Class B skin layers.

The contract for the dam included clearing and grubbing of the actual dam site and as far as 500 ft. upstream. Clearing 1,800 acres and grubbing 25 acres that comprised the remainder of the reservoir area were done under two contracts supervised by the bureau of water supply. Road and bridge work made necessary by the reservoir formed by the dam was done under contracts supervised by the bureau of highways.

Practically all of the 410,000 cu.yd. of earth and rock excavation was removed by gas-powered shovels and trucks. The specifications called for the excavated materials to be placed in a cove upstream from the dam and along the highways adjacent to the abutments to provide parking space. Because of the heavy increase in excavation and in order to eliminate a long haul over temporary roads up the sides of the valley, the contractor built double concrete ramps straight up the hillside, on each side of the valley, a short distance upstream from the dam. These ramps were on 46 and 44 per cent slopes. Loaded trucks were hauled up the ramps by cables operating from power hoists set at the top. Empty trucks were lowered in the same manner.

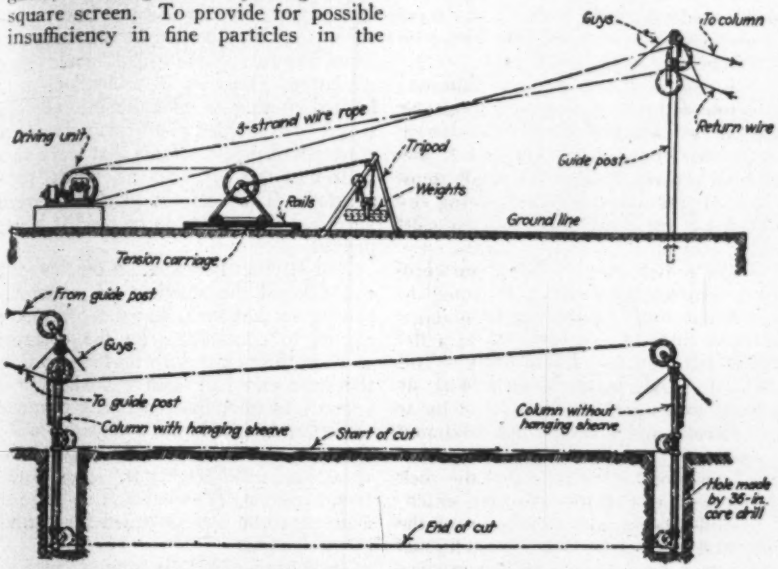


Fig. 3—Wire saws cut out most of the deep cutoff trench under the heel of the dam. Actual cutting is done by a traveling wire operating between sheaves at lower end of columns. Columns are set up in 36-in. calyx drill-holes.

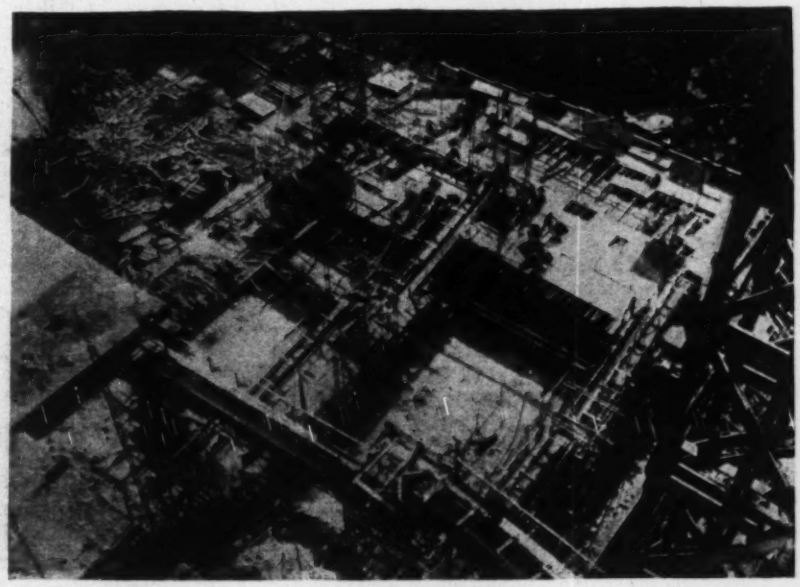
Material for backfilling the excavated area on both sides of the corewall was delivered by trucks to the upstream embankment and by trucks and tractor-pulled crawler wagons to the downstream fill. All filling material was spread by bulldozers and was thoroughly rolled.

River control

Most of the time, during the early stages of the work, the streamflow was taken care of through temporary channels, shifted as required. During this period the excavation was protected by earth and sandbag levees. After the concrete work had sufficiently progressed, the streamflow was handled through two 48-in. openings left through the lower lifts of the gatehouse concrete. The streamflow was directed into these openings by a concrete cofferdam on the upstream side, and a rock-filled crib cofferdam protected the excavation west of the gatehouse on the downstream side. Short cast-iron flanged nipples protected the two ends of these openings. The gates were closed April 10, 1933, when impounding of water began. Several times during the construction operations floods occurred, as was expected, which exceeded the capacity of the openings, temporarily holding up the work for a few days and causing some minor damage to the cofferdam. The streamflow openings were designed to pass only small floodflows, making it necessary for the engineers later to order leaving down a 34-ft. length of the west overflow section, to El. 490, until the construction of the corewall and the backfilling had sufficiently progressed to prevent overtopping.

Since it was important to disturb as little as possible the rock to be left in place, light shooting was required throughout the lower part of the excavation. All drilling, except for grout

Fig. 4—During first stages of construction the concrete was distributed by a system of pipe towers and short-trussed belt conveyors, with final placement by buggy. Buggy platform shown in left of view is carried on pipe scaffolding built up within concrete.



holes, was done with jackhammers. In excavating the cutoff trench, the specifications required that the trench be channeled on both sides before the shooting operation so as not to disturb the adjacent rock.

Wire saws

The contractor was allowed to replace the channeling machines specified for this work with wire saws. A layout of the wire-saw arrangement is shown in Fig. 3. The operation was as follows:

Two 36-in. holes were drilled with calyx drills from 30 to 90 ft. apart and to a depth slightly below the bottom of the future trench. Vertical steel columns were set in these holes, each carrying two sheaves, one swivel-mounted on top, the other traveling vertically on a screw feed. At the start of a cut, the travel sheaves were placed at rock level. From a distant driving unit, a continuous $\frac{7}{16}$-in. or $\frac{1}{4}$-in. three-strand wire traveled to the top sheave of one post, down to the corresponding traveling sheave, across the rock face to the other traveling sheave, up through the swivel sheave on this post and back to the driving unit. At the driving unit a weight and carriage arrangement kept the line in tension. Sand and water were fed into the groove made by the moving wire in the rock face. As the groove deepened, the traveling sheaves were lowered by a hand-operated screw feed. The saw sets were placed in pairs, one set on each of the outer lines of the trench. The rate of cut averaged about $\frac{3}{4}$ in. per hour. On the west end of the cutoff trench the wire saws were supplemented by line-drilling and broaching methods.

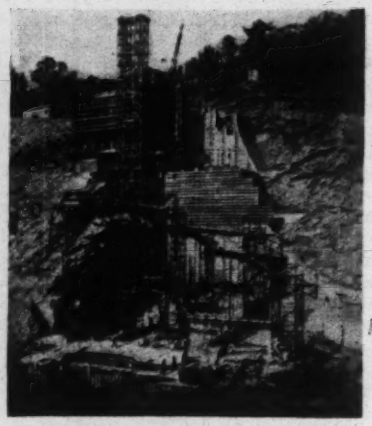


Fig. 5—First concrete plant and placing operations. Concrete was taken from hoist tower by belt conveyors at various levels.

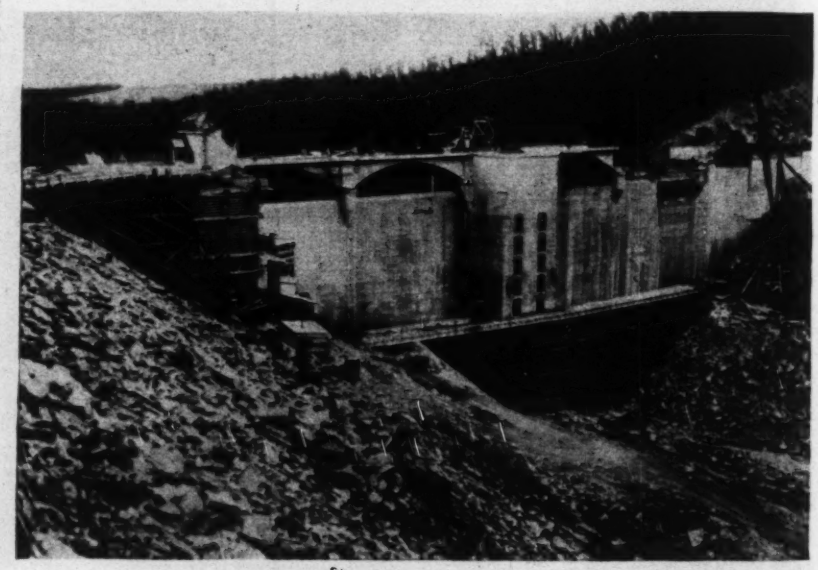
Concrete plant

The mixing plant was set on the hillside adjacent to and upstream from the east abutment. All aggregates and cement were delivered by truck. A timber platform was built out at the upper roadway level, from which trucks were dumped directly into any one of a row of seven wooden storage bins, each bin holding one of the six different coarse and fine aggregates. Each bin fed into a volumetric batcher equipped with a scale beam, so that either volumetric or weight measurement could be used. The batcher, in turn, dumped onto a single 30-in. belt conveyor. This conveyor delivered the aggregate to either of the receiving hoppers over the two 2-yd. tilting mixers. Each batch was proportioned by feeding a predetermined amount of each of the proper aggregates onto the belt conveyor. Hand-operated feeding gates, built as a part of each batcher, controlled the flow from the aggregate bins, except on the cobble bin, the feeder from which was operated by air.

At first the cement was received in bags, which were chuted from trucks to a storage room under the truck platform or directly to a platform over the receiving hoppers. Later the bulk cement was used, being dumped from the truck platforms through a small receiving hopper and a connecting steel pipe directly into a lined timber storage bin built above the mixers. From the storage bin the cement was delivered by two hand-controlled electrically operated screw conveyors to two weighing hoppers, each provided so as to discharge into one of the receiving hoppers over the mixers.

The greatest change in construction methods was in the concrete distribution system. The first distribution system consisted essentially of a series of 50-ft. portable trussed frames, carrying belt conveyors, supported at either end by tubular steel towers built up above and left in the concrete in both the dam and aprons (Fig. 6). From the mixers concrete was hoisted by bucket up a tower to the main conveyor system extending along the structure. From the towers on the main system additional conveyors extended downstream to other similar towers. When depositing at levels below the level of the main conveyors, concrete was dropped through square elephant-trunk flexible spouts into hoppers feeding the next lower conveyor unit or the distributing hoppers. Final disposition was usually made from the latter by buggies (specifications prohibited chuting of concrete into place), rolled over wooden platforms carried on a system of pipe scaffolds that were also built into the concrete as work progressed. The scaffold platforms were kept just above the top of the lift being poured.

Fig. 6—First system of belt conveyors was later replaced by conventional train and derrick system with bucket placement. Trains operated over trestle built along upstream face of dam.



The increased excavation on the west end delayed the starting of concrete-placing in that area, and the contractor elected to concentrate on the concrete work in the east end, so that by the time the west end had been excavated sufficiently to start the remaining concrete work the dam had been completed to the crest level on the sections east of the west side of the gatehouse. This condition, together with the large increase in concrete to be placed, called for certain plant changes.

In March, 1932, it was decided to change over the concrete-distribution system. The new system called for bucket placement entirely. A trestle was built leading from the mixing plant across the lower part of the valley, 40 ft. upstream from and parallel to the upstream face of the dam. This trestle carried standard-gage tracks at El. 452 and extended from the mixers to the west bank. The trestle carried a double track as far as the gatehouse and a single track beyond. A crossover between tracks was placed at the mixer

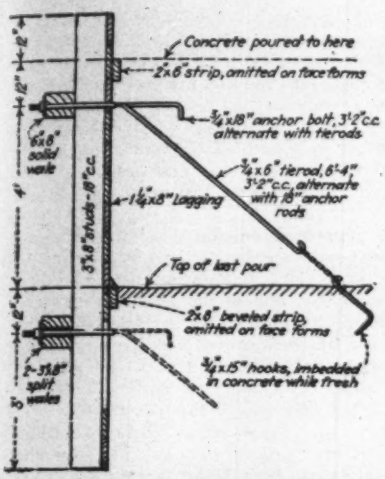

Concrete poured to here
2x6" strip, omitted on face forms
6x8" solid wale
1¼x8" Lagging
Top of last pour
2x8" beveled strip, omitted on face forms
2-3x8" split wales

Fig. 7—Form system used with second system of concreting consisted of easily handled panels 20 ft. long held in place by ties and anchors. Seating strip at bottom greatly facilitated setting of inside forms.

end. Two cars, equipped with a 2-cu.yd. side-discharge hopper, hauled by gasoline locomotives, delivered concrete to a whirley crane and the derricks.

A steam whirley crane with a 75-ft. boom was mounted on a track carried on the crest of the completed sections. Drop-bottom buckets of 2-yd. capacity handled by the crane received concrete from the side-discharge car hoppers, the buckets being spotted on a platform on the trestle in correct position for receiving the concrete and eliminating the hoisting and lowering of the boom. As the cofferdam was completed to crest level, the crane moved out and worked on the next sections. The use of the whirley crane was continued to the west end of arch No. 4.

Over the lower-lying portion of the excavated area of the dam, west of the gatehouse, a steel trestle 85 ft. long was erected, on which a traveling stiff-leg derrick was mounted. The boom of this derrick was 90 ft. long and handled the 2-cu.yd. buckets. The derrick also spotted buckets on the concrete trestle and placed all the lower concrete in the sections of the dam between the gatehouse and the west end of arch No. 4. A second stiff-leg derrick was set up in fixed position on the upstream side of the dam commanding the west gravity sections and the transition section. For a part of the time this derrick was temporarily fed by a shuttle car mounted on a temporary trestle receiving concrete at the end of the main concrete trestle. A second stiff-leg derrick was set up in a fixed position on the upstream side of the dam commanding the west gravity sections and part of the corewall. For a part of the time this derrick was fed by a shuttle car that received concrete at the end of the main trestle. Later the traveling derrick was reset in a fixed position on the upstream side of the dam to receive concrete from the west end of the concrete trestle, commanding the remaining gravity sections of the west end. This derrick also relayed material and concrete to the derrick set up on the far west end. The maximum day's output of concrete, using two booms, was 1,380 cu.yd. in two shifts. The earlier belt-conveyor system placed 1,637 cu.yd. in the maximum day of the same length.

With the conveyor and scaffold system the tower and scaffold posts and pipe dowels provided anchorage for the form panels. With the switch to bucket placement, a different type of form panel was developed, as shown in Fig. 7. Panels were generally built up in 20-ft. lengths for 5-ft. lifts, using a double 3x8-in. split lower wale, a 6x8-in. upper wale, 3x8-in. studs and 1¼x8-in. lagging. The wales were spaced 5 ft. apart, the upper wale being 1 ft. below the top of the concrete lift. Through the top wale were placed ¾-in. bent tierods fastened to hooks buried in the surface of the previous pour. Alternating with the tierods were short horizontal anchor bolts. These tierods and anchor bolts, buried in the concrete, became the anchors for the lower wale on the succeeding concrete pour. Except on the outside faces of the dam, a 2x6-in. horizontal strip fastened inside the form at the top of the lift left a convenient groove to take a corresponding seating strip in the lower part of the form. This seating strip facilitated setting of the form.

Grouting

A systematic schedule of foundation grouting was carried on throughout the entire upstream one-third area under the dam. Grout holes were drilled 20 ft. deep and 9 ft. c. to c. both ways. Extra holes were drilled into all rock seams in this area. Grouting was done with a special electrically driven reciprocating pump fed by an agitator grout mixer. The specifications called for grouting pressures up to 100 lb. per sq.in., but pressures in excess of this figure were used at numerous points where rock conditions made them desirable.

Power plant

The electric power required on the job was generated at the site by a steam generating plant erected by the contractor. This plant was equipped with boilers totaling 375-hp. capacity and three steam engines, the engines operating four 50-kw. generators. Electricity produced by these generators operated the concrete-plant hoists, water pumps, wire saws, calyx drill and lighting circuits. The contractor installed a complete tool-dressing and drill-sharpening shop, with oil-heated forges and an air-driven sharpening machine. A complete carpenter shop and a small machine shop were also set up on the job.

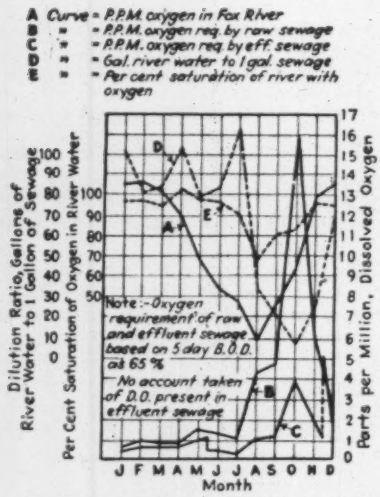
The dam and reservoir were built by the department of public works of the City of Baltimore under the direct supervision of Bernard L. Crozier, the present chief engineer of the department, who succeeded the late Charles F. Goob. The work was financed out of water-loan funds administered by the Public Improvement Commission, of which H. Webster Smith is chairman. Leon Small is water engineer of the bureau of water supply and will have charge of operation after completion. John H. Gregory was consulting engineer, and Joseph T. Singewald was consulting geologist for the city. C. B. Cornell was construction engineer in direct charge of all the work except the highway and bridge work in the reservoir area, which was done under the direction of George Cobb, who succeeded Nathan L. Smith as highway engineer of the bureau of highways.

The J. A. Laporte Corp., Albany, N. Y., was general contractor for the dam, with Joseph A. Laporte in direct charge. Morris H. Spamer was construction engineer for the contractor.

Third-Year Operation Data of the Aurora Sewage-Works

MAKING READABLE to the average citizen the reports of the operation of sewage plants is one of the municipal engineer's most difficult jobs. As an example of presentation of such statistics, involving m.g.d.'s and B.t.u.'s and B.O.D.'s, the second annual report of the Aurora, Ill., sewage-treatment plant is notable. In the first place, the report refers to "treatment" and not "disposal." Also, while the report gives the volume treated as 7.2 m.g.d., the writer goes on to say that this is equivalent in a year to a 10-ft. depth in a canal the width of a 40-ft. superhighway, 166 miles long, from Aurora to Iowa City. Coarse screenings equivalent to 126 12-yd. dump cars, were burned to ashes in an incinerator. Gas produced in the digesters was of 632 B.t.u. value, or 21 per cent less than the ordinary domestic gas, and enough was produced to heat 400 Aurora homes for a year or to fill a local gas-holder six times. Mr. Sperry's report was mimeographed, not printed, but it ought to be made available for the good example that it sets to municipal engineers. It is abstracted below. —EDITOR.

THE OVER-ALL reduction in biological oxygen demand (B.O.D.) during the third year, 1932, of the operation of the sewage-disposal plant of the Aurora (Ill.) Sanitary District was 75.5 per cent, from 102 to 25 parts per million (p.p.m.). Of suspended solids the reduction was 81.5 per cent, from 140 to 26 p.p.m., and of settling solids 90.8 per cent. The plant, of 6.5-m.g.d. nominal capacity, which consists of bar screens, grit chamber, plow-type settling


A Curve = P.P.M. oxygen in Fox River
B " = P.P.M. oxygen req. by raw sewage
C " = P.P.M. oxygen req. by eff. sewage
D " = Gal. river water to 1 gal. sewage
E " = Per cent saturation of river with oxygen
Dilution Ratio, Gallons of River Water to 1 Gallon of Sewage
Per Cent Saturation of Oxygen in River Water
Parts per Million, Dissolved Oxygen
Note:-Oxygen requirement of raw and effluent sewage based on 5 day B.O.D. at 65 %
No account taken of D.O. present in effluent sewage
J F M A M J J A S O N D
Month

Relation between oxygen supply in river and oxygen demand of raw sewage and plant effluent.

basins, separate sludge digesters, sludge beds and sprinkling filters, was put into service in 1930 and serves a connected population of 47,000. Its purpose is to eliminate a nuisance in the Fox River into which the sewage formerly discharged. Had there been no sewage plant in 1932, according to the annual report of W. A. Sperry, superintendent, the river with its unusually low stage would have been foul and septic from July to November. As it was, the treatment kept the stream fresh, clean and normal, with fishermen and recreation seekers unusually numerous at every available spot downstream for many miles. On account of the depression this condition of the stream made the plant a peculiarly valuable asset to the community.

As an economy measure the filters were operated only from May 21 to Nov. 17, the river having a volume to produce a dilution sufficient to care for the oxygen requirements during the off-season periods, as indicated by the accompanying charts. The ratio of sewage effluent to river water was 1 to 71 on the average.

The pounds of oxygen per capita for 5-day B.O.D. in the raw sewage was 0.130 lb., and the pounds of suspended solids per capita in the raw sewage was 0.178 lb. The average time of retention in clarifiers was three hours. The methyline blue stability of the effluent when the filters were operating was seventeen days, and when not running it was ten days.

During the year the plant treated 2,636,000,000 gal. of sewage, an average of 7.2 m.g.d. This is 1.4 m.g.d. more than in 1931 and 2.4 m.g.d. more than in 1930. The increase is due to storm-water and the use of flushing water from the river, let into the upper end of the intercepter to control odor conditions in the summer.

Screenings (126 yd.) increased 41.3 per cent over 1931, while sand, cinders and street washings (183 yd.) decreased 5.9 per cent. Grease (41 yd.) was 28.2 per cent less than in 1931. Screenings and grease were burned in the gas-fired incinerator (*ENR*, Feb. 25, 1932, p. 283), and the grit was used for filling around the yard.

The removal of fine settleable solids (which is the materal causing the greatest damage in the river) from the clarifiers to the digesters increased from 650 tons in 1931 to 732 tons in 1932. The effect was to produce more gas as well as to deliver a better effluent to the river.

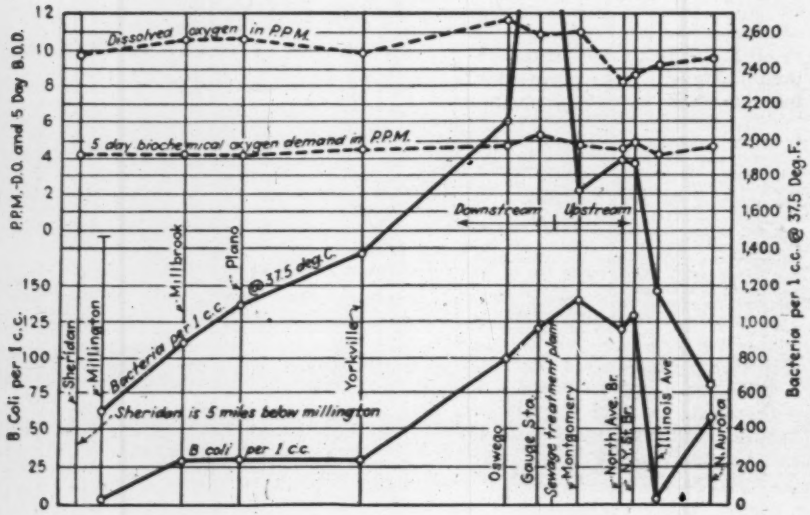
Gas produced was 12.4 million cu.ft., an increase of 17.2 per cent, or 5,000 cu.ft. per day. Heating value was 632 B.t.u., 21 per cent less than the city gas. It is estimated it would have supplied 400 average Aurora homes. The gas produced weighs 392 tons, being 53.5 per cent of the solids converted to gas by bacterial action in the digesters and burned in three plant furnaces, saving all fuel bills. Gas produced per pound of volatile matter added to the digesters was 12.8 cu.ft. Likewise 19.8 cu.ft. of gas was produced per pound of volatile matter destroyed. Based on the gas produced, the volatile matter was reduced 80.7 per cent.

About 1,150 cu.yd. of sludge was entirely removed by the public for use as fertilizer, mainly on golf links. It averaged 2 per cent nitrogen and 40 per cent humus.

Increased efficiency of the clarifiers was obtained by virtue of experimentation. The variation in flow had been such that one of the four clarifiers got twice as much flow as another, while two of them were close to the 25 per cent that each should have received. When corrected with baffles and by resetting the weirs the variation was 25 per cent, plus or minus, of the theoretical. Performance in removal of suspended solids had been unequal, running 57, 46, 72 and 46 p.p.m., a variation of 33.2 per cent above to 27.6 per cent below the average. Dye and salt tests were made, checking the unequal distribution. The internal tendency of the tank to short-circuit was caused by cross-currents under the inlet trough set up by the high velocity of the inlet flow. This effect was checked by a series of vertical baffles 5 ft. apart placed at right angles to the inlet troughs against the inlet wall, but under the inlet trough and behind the existing inlet baffle. These baffles stopped cross-currents under the troughs and delivered the sewage uniformly across the tank toward the outlet side. With these changes, suspended solids removed increased from 39.4 per cent for a fifteen-month period previous to the change to 60.3 per cent for a nine-month period afterward. Conclusions reached were that speed of bridge does not interfere with settling efficiency when inlet and outlet conditions are correctly controlled. This permitted eliminating two of the four clarifiers during the "off" filter season, saving maintenance care and current cost of $15 to $20 per month.

Costs of operating the treatment plant and intercepter system, excluding overhead such as bond interest payments, insurance premiums and officers' salaries (except that of the superintendent), were as follows per million gallons: payroll, $6.44; power, $2.04; truck, $0.036; office and phone, $0.124; laboratory, $0.129; new equipment, $0.295; repairs, $0.297; miscellaneous, $0.46; total, $9.82. In 1931 the total was $12.10. The repair and maintenance of the intercepter system cost about $400.

Relation between bacteria, B. coli, dissolved oxygen and 5-day B.O.D. in Fox River above and below Aurora sewage-treatment plant.



Earthquake Motions—A Correction

In the article "Destructive Earthquake Motions Measured for First Time" (*ENR*, June 22, 1933) the caption of the illustration on p. 806 should have given the vertical measurement 0.05*g*, instead of 0.5*g*.

Operating Economics of Highway Grades

Analysis based on various theories and experiments indicates that universal grade reduction is not substantiated by operating economies

By Nathan W. Dougherty
Professor of Civil Engineering, University of Tennessee, Knoxville, Tenn.

AS MUCH confusion exists in the evaluation of highway grades as in almost any other phase of highway design. Railway-locating and designing engineers have measured resistances and engine performance, and know pretty well what it will cost to operate any rate or length of grade. Their problem is simple when compared with the same problem on the highway. Their engines are not overpowered, they cannot shift gears, and the air resistances are a small amount of the total resistance. In highway operation there is no such thing as a maximum plus grade. Vehicles can ascend any grade that they can safely descend. There is some inconvenience to the driver and some loss in speed and efficiency, but by shifting gears the modern motor vehicle can be made to ascend practically any reasonable grade that the highway engineer is forced to use. The problem is not one of limited loads but rather of economics of operation and of cost of construction and maintenance.

W. G. Harger, in "Location, Grading and Drainage, 1921," suggests a solution. If energy is stored in the vehicle on the ascent, it may be used in overcoming resistances on the descent. The amount of recovery, of course, depends upon the permissible speed at which the descent can be made. Should the vehicle attain the summit of the grade at a given speed and continue that speed down the hill, the loss will be the difference between the energy stored in the car due to position and the energy used in overcoming resistance coasting down. To this loss should be added the consumption of fuel on the descents. Mr. Harger suggests, with proper corrections, that the loss on a 5 per cent grade, where resistances are equivalent to a coasting grade of 2.5 per cent, is $\frac{5.0-2.5}{5.0}$, or 50 per cent of the energy due to position.

He then converts his vertical distance into horizontal distance by equating energy lost to energy needed to travel horizontal distances. For constant speeds this method is as good as any other yet presented.

In most vehicle operation on good alignment there is a decrease in speed as the vehicle ascends the grade and an increase in speed as it descends. This adds at least three complications. Air resistances vary, the efficiency of the motor varies, and the kinetic energy in the car changes. Air resistances vary as the square of the speed, and the latest information indicates that the amounts (for the usual model car in 1932) are large enough to increase greatly the coasting grades heretofore suggested. The coasting grade, gears engaged, may easily reach 6 per cent for speeds up to 45 and 50 miles per hour.

Prof. T. R. Agg, in "Construction of Roads and Pavements 1929," shows the relation between resistances and speed. He also shows the distances needed to change from one speed to another with constant resistances, and with different rates of grade. The writer suggests the following equation as an addition to the usual discussion. The equation may have been developed many times before, but its use in the present connection is not recalled.

If, on the descent, the work of gravity is equated to the work done in overcoming resistances and increasing speeds, the following equation results, assuming that air resistances vary as the square of the speed.

$$h = \frac{Rh}{pW} = \frac{-C}{2gK} \log_e \left(\frac{V_2^2 - \frac{C}{K}}{V_1^2 - \frac{C}{K}} \right)$$

where R is rolling resistance; p rate of grade; W weight of vehicle corresponding to R; $C = pW - R$; K = coefficient of air resistance times area of car exposed to this resistance; h = vertical height in feet; V = speed in feet per second; g = acceleration of gravity. Distances along the grade may be found by dividing h by p or $D = \frac{h}{p}$ (A similar equation may be developed for ascending grades.)

The solution to this equation is shown in Fig. 1, assuming K to be .029 for speeds in miles per hour and assuming that the accelerating force is proportional to the rate of grade.

The distances are those required on the different rates of grade to change the speed from one value to another. For example, on a 5 per cent grade it requires 6,870 ft. to change the speed from 35 miles per hour to 45 miles per hour.

Fig. 2 is constructed to show the distances needed to change the speed from 25 to 35, 35 to 45 and 45 to 55 miles per hour, provided, of course, that the air resistances are as above assumed and that the rolling resistance is 40 lb. per ton.

The curves further show that the speed will not increase above 35 miles per hour for a 4 per cent grade, 45 miles per hour for a 5 per cent grade and 55 miles per hour for a 6 per cent grade. If the alignment is safe for

Fig. 1—Distances required on different rates of grade to change the descending speed from one value to another.

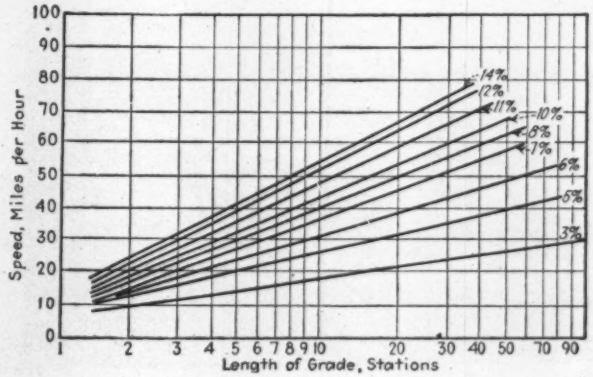
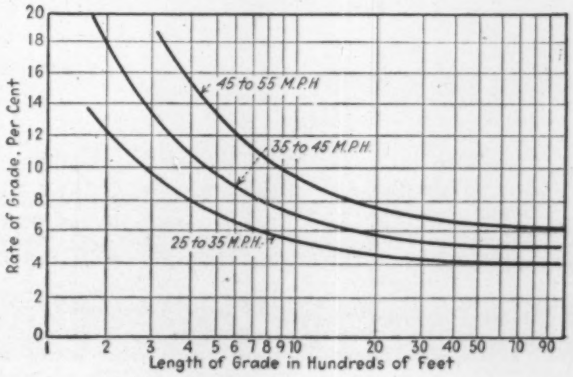


Fig. 2—Distances required on different rates of grade to change the speed from 25 to 35, 35 to 45 and 45 to 55 miles per hour, and grades at which speeds will not increase.



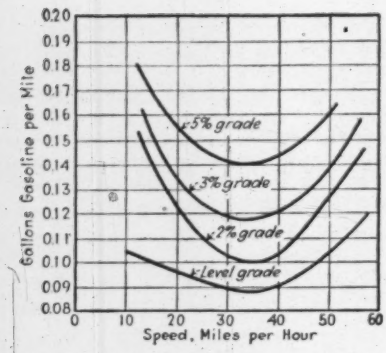


Fig. 3—Gasoline consumption on different grades and at various speeds.

these speeds, there will be no loss of energy because of the application of brakes.

If the energy can be stored in the vehicle at a reasonable efficiency, it is possible to operate grades without making excessive demands upon the gasoline tank. Mr. Paustain, of the Iowa State College, has furnished the writer with efficiency curves for a car that he is using in some very valuable experiments. From his curves Fig. 3 has been constructed, showing gasoline consumption for different rates of grade. In making the computations a vehicle weighing 3,000 lb. was assumed. The absolute values may be inaccurate for any particular automobile, but for a vehicle that has similar efficiency curves the relative values may be used. Notice that 35 miles per hour gives the minimum gasoline consumption per mile. This figure will probably vary from 30 to 40 miles per hour for different vehicles.

If a vehicle ascends a 5 per cent grade at 35 miles per hour and descends on a good alignment, it is possible to operate the grade at a saving in gasoline. The vehicle may coast, engine idling, the whole length of the descent. For the ascent the vehicle is using 60 per cent more gasoline than it would use at the same speed on the level. If therefore, the consumption idling is less than 40 per cent of the demand on the level, there may be a saving in gasoline.

The figures thus given may be very approximate, and of course they will have to be revised for commercial vehicles, but they are given as pointing to a reasonable discussion of highway grades. Obviously short grades that do not exceed the length needed for the allowable changes in operating speeds may be operated as economically as the level grade. Their design is a matter of safety, drainage, construction and maintenance cost, and not one of operating economies. For passenger vehicles operating on alignment that will be safe for speeds of 45 miles per hour there is no economic reason for changing a 5 per cent grade to any less value. There is some rate of grade, probably between 3 and 4 per cent, that may be operated by trucks with like economy. Its value may be fixed by measuring air resistances on trucks and by constructing performance curves.

The time element has not been considered in the above computations. Suffice it to say here that for automobile travel as now occurring on the road the writer doubts whether the loss of time on the ascending grades will change the conclusions stated above.

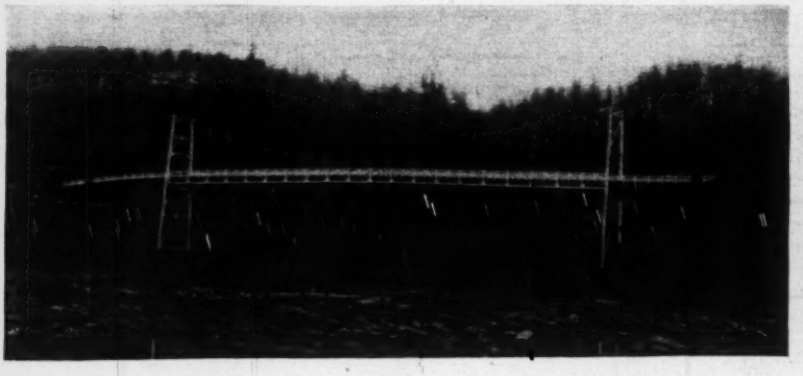
Short-Span Suspension Bridge Uses Prestressed Rope Cables

In new 300-ft. Lewis River crossing near Yale, Wash., the cable arrangement, tower top and anchorage details, the stiffening truss and roadway design are indicative of what can be done in the field of short-span suspension bridges

By H. O. Blair
Consulting Engineer, Tacoma, Wash.

THE NEW suspension bridge built jointly by Clark and Cowlitz Counties over the north fork of the Lewis River near the town of Yale, Wash., owes its existence to the construction of Ariel Dam. Backwater from this dam put the existing wood and steel truss bridge out of service, and in addition attained a depth of 90 ft. at the new bridge site, making it unusually difficult to place falsework for the usual type of highway bridge. A suspension structure therefore was designed and built at a cost of $40,000. The bridge is located about 22 miles from the town of La-Center on the Pacific Highway and is 55 miles from Portland on the roads through Vancouver and Yacolt. It was completed late in 1932.

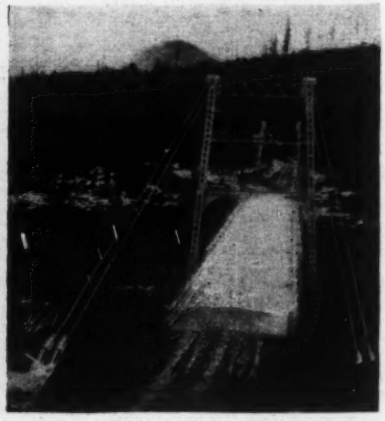
Fig. 1—Suspension bridge of 300-ft. main span providing a crossing of the Lewis River, which at this point has a depth of 90 ft. by virtue of the construction downstream of the Ariel Dam.



The bridge has a main span of 300 ft. and an over-all length of 532 ft. Cable sag is 30 ft., and the backstays are unloaded. Towers 332 ft. high give the roadway a clearance of 50 ft. above high water. The steel stiffening trusses are 20 ft. on centers, made up of rolled H sections, and support the floor beams for a timber deck that furnishes an 18-ft. roadway, which was designed for an H-10 loading.

In designing the bridge special thought was given to erection requirements, and as a result a number of novel details were developed that contribute to simplified erection. The main cables consists of four 2⅞-in.-diameter galvan-

Fig. 2—Four wire ropes constitute the cable system of the new suspension bridge near Yale, Wash. An 18-ft. timber-deck roadway is provided.



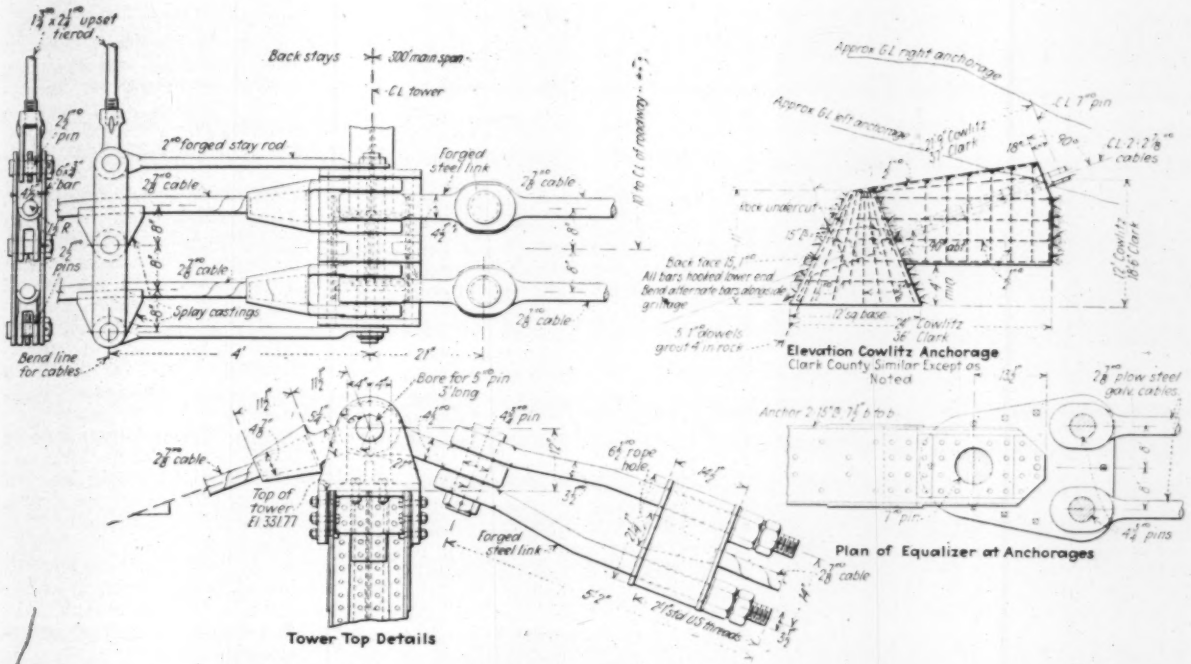


Fig. 3—Tower top and anchorage details of Yale suspension bridge. Main span and backstay cables fasten to castings on the tower tops. Anchorages were given a pyramid shape and keyed into the rock to provide greater resistance to overturning.

ized plow-steel ropes of 7x19 construction. The calculated tension on each of the four cables was 114 tons due to live load, dead load and temperature, and they were designed for 342 tons breaking strength or a factor of safety of three. The ropes were prestressed to 75 tons and the lengths cut off under this stress. The wire ropes were manufactured, prestressed, and the fittings were socketed on at the plant of the Hazard Wire Rope Co. at Wilkes-Barre, Pa. The main cables are cut, discontinuous at the towers, being attached to the steel castings at the tops of the towers; the fastenings are so fitted with links and pins to these castings that the action approximates that of a swivel joint. This detail simplified erection and in addition avoided any wear on the main cables and permitted the use of small-sized cables.

The anchorages were designed as gravity anchorages, but an additional factor of stability was provided by using a pyramid-shaped base that was keyed into the rock banks.

The bridge was designed by Harold H. Gilbert and was built by the Gilpin Construction Co., of Portland, Ore.

Forty Years of Progress in Engineering Education

Addition of graduate study and research and increased emphasis on social and economic studies for engineers are emphasized at the Chicago convention of the S.P.E.E.

By Clyde W. Park
Professor of English, University of Cincinnati

AT ITS fortieth anniversary meeting, held at Chicago during the week of June 26, the Society for the Promotion of Engineering Education took stock of developments in the training and status of the engineer since the society was organized. Present conditions and probable trends for the future were interpreted in the light of historical perspective.

The Society, long known by the familiar abbreviation "S.P.E.E.," was originally formed, under the chairmanship of Prof. Ira O. Baker (University of Illinois) as Section E of the engineering congress which met at the Chicago World's Fair in 1893. Of those who helped to organize the section into a permanent society, 21 survive, including Prof. C. Frank Allen (Massachusetts Institute of Technology), a member of the original constitution committee, and ten of these were present at the 1933 meeting. The society now has a membership of 2,266, made up of practicing engineers as well as teachers, and representing nearly 200 colleges in the United States and Canada.

In his presidential address on "The Function of Engineering Schools in the Economic Life of the Country," Dean R. A. Seaton (Kansas State College) showed the contrast between the problems of engineers a generation ago and today. In 1893, for example, the technical graduates, numbering approximately 1,000 for all the colleges, went out into comparatively simple tasks, chiefly in the fields of civil, mechanical and mining engineering; automotive and industrial engineering were still in the future, and the service of the electrical engineer to industry and in public utilities was only dimly foreseen. The 9,000 to 10,000 young engineers who now leave the colleges annually go out into a more complex situation to face greater responsibilities and more diversified tasks. The engineer of 1893, preoccupied with structures and machines, was the master of materials and forces and the servant of industry. Since then his work has led him increasingly into basic and specialized research or into positions of management, in which he must reckon with economic and social forces.

With reference to this latter development, President W. E. Wickenden (Case School of Applied Science) showed that the crowding of our population and the thinning of our resources are compelling us to take a more broadly socialized view of the engineer's responsibilities. Europe, he pointed out, has been more consciously collective than America in the past, but we are now approaching a planned society. Dean A. S. Langsdorff (Washington University) recalled that engineers were once the hirelings of business men, whereas recently many engineers have themselves become business leaders and have undertaken wider and more responsible forms of public service. At the same time, he said, the engineer has progressed from the merely practical man of the '90s, trained in mechanical arts and empirical knowledge, to the research worker.

Changes in training

The changing picture of engineering is reflected to some extent in the shifting emphasis on subjects of instruction in technical colleges. Typical changes were shown by Prof. W. T. Magruder (Ohio State University) in a survey of mechanical engineering studies today as compared with those required 25 years ago. Decreases were noted in foreign languages, drawing and shopwork, which latter is often replaced by cooperative experience or anticipated by manual training in the high school. Increased time was reported for surveying, electrical engineering, English as a tool of expression, economics, business and management. Several colleges have added introductory or "orientation" courses.

Although these freshman courses are usually studies of the elements of engineering, a different type, recently added by the Armour Institute of Technology, was described by President Willard E. Hotchkiss. Freshman students are to be introduced to social and political problems, in order to develop their thinking in the direction of the newer engineering interests and to give them flexibility. Following the study of economics in the junior year, the students will round out their college course with a study of larger social and economic problems, involving competition, marketing and the trends of population growth. These new studies have been added as the result of an investigation in which 100 employers in the Chicago area participated. The consensus of employers regarding the need for broader training is summed up in the following statement by James D. Cunningham on the Armour Institute plan:

> The vision of the engineering graduate has actually been limited by his education. He does not express himself well; he has a good knowledge of engineering subjects, but he is incapable of generalizing from that knowledge; and not only does he know little except engineering, but he also knows almost nothing of the economic and social significance of engineering.

Although the need of additional or collateral study was generally accepted, there was little sentiment in favor of lengthening undergraduate courses to five years. A plea for post-graduate education for engineers that would increase their familiarity with economic and social subjects was made by Prof. V. M. Faires (Texas A. & M. College). He proposed a program of correspondence study of the humanities, covering subjects for which no time is found in the undergraduate curriculum. This additional study would keep the graduate abreast of new developments and might be recognized by the awarding of an A.B. degree. Similar suggestions were made for extension courses in urban centers.

Further assistance in the engineer's advancement was proposed by the Engineers' Council for Professional Development in a report submitted by the chairman, Col. R. I. Rees (American Telephone and Telegraph Co.). The council, representing and working with the national engineering societies, has drafted a comprehensive plan for (*a*) the selection and guidance of prospective engineering students, (*b*) the maintenance of standards in engineering schools, and (*c*) professional recognition. These three divisions are in charge respectively of the following committee chairmen: Dean R. L. Sackett (Pennsylvania State College); President Karl T. Compton (Massachusetts Institute of Technology); and C. N. Lauer (Philadelphia Gas Works). The activities of these committees, all of which are related to Colonel Rees's committee on professional training, will have to do with such matters as restriction of enrollment to students of special aptitude and ability for engineering, accrediting of engineering schools and fixing requirements and standards for professional degrees. In addition, licensing and registration of engineers will be studied and analyzed.

Better teaching methods

In accordance with tradition dating from its origin, the society gave much attention to the discussion of methods for improving the quality of teaching in engineering schools. Specific plans for teaching English, drawing, mechanics, electrical engineering and other subjects were considered at section meetings for special groups. A feature of this meeting was a joint session of teachers of English with instructors in drawing, in which methods of obtaining better written and better illustrated reports were discussed. A general proposal for freshening methods of approach and avoiding conventional and perfunctory teaching was made by Prof. Dugald C. Jackson (Massachusetts Institute of Technology) in a plan for the exchange of instructors between colleges. It was recalled that for the past ten years the society has held summer schools for teachers of specific subjects, such as mathematics, mechanics and drawing, which provided opportuity for an exchange of views between representatives of different colleges. These schools are under the direction of Prof. H. P. Hammond (Brooklyn Polytechnic Institute).

Inspiration to be drawn from great teachers was emphasized by Dean Dexter S. Kimball (Cornell University) in an address on "Personalities of Engineering Educators." In his list of qualities needed to produce a good teacher, Dean Kimball included, along with scholarship, the power of expression or illustration and the power to incite or to arouse enthusiasm. Fairness and a sense of humor, he said, are also important. Citing illustrations of these qualities and of the methods and pecularities, even eccentricities, of famous teachers of the past, he gave a vivid and human account of college teaching at its best.

Following his address, Dean Kimball was announced as the recipient of the Lamme medal for 1933 in recognition of distinguished service in the field of engineering teaching.

Three periods, under the chairmanship of President A. R. Cullimore (Newark College of Engineering), were devoted to section meetings on cooperative training of engineering students. Special reference was made to experiences with student employment during the economic dislocation. Prof. W. H. Timbie showed how M.I.T. has made the necessary adjustments to keep students profitably employed by taking advantage of the elasticity inherent in the cooperative plan. Others told of cultural studies provided for students who were temporarily without cooperative jobs, and of projects for employing students to design and build equipment for the college.

A number of meetings were held in connection with the engineering groups that were in Chicago for Engineers' Week.

Officers elected for the next year are: president, W. E. Wickenden (Case School of Applied Science); vice-presidents, F. V. Larkin (Leigh University) and B. M. Brigman (University of Louisville). F. L. Bishop (University of Pittsburgh) was re-elected secretary, and W. O. Wiley (John Wiley & Sons) was re-elected treasurer. The 1934 meeting will be held at Ithaca, N. Y.

Flood-Relief Weir on the Sacramento River

The caption under a picture of the Colusa weir of the Sacramento flood-control project, on p. 618 of our issue of May 18, 1933, was incomplete. It should have stated that the weir shown was built jointly by the United States, state and local interests.

Ten Business Problems of Contracting

I—Learning the Philosophy of Profit

Contracting is a series of problems in buying and selling—Service alone justifies profit—Unrestricted competition is disastrous to profits—Philosophy of capital and profits—Business cycles, price levels and profits

By J. L. Harrison
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UNDER the new order established, at least temporarily, for industry, the contracting business has need to review many of its problems and practices. In a series of ten articles, which will be published fortnightly during the next four months, the more important of these problems will be presented and discussed by a thoughtful student of the contracting business.

In publishing these articles there is no thought of presenting a complete manual on contracting. They will consider neither all the problems of the business nor say all that can be said concerning any problem. Rather they are a series of discussions of selected problems intended to provoke consideration and further thought by those who have actually to deal with them. Also, they are not articles on contracting.

In his two decades of connection with engineering construction the author of the articles has served as inspector, has supervised construction and has been engineer in charge; as an engineer of the Bureau of Public Roads he has precisely analyzed the management and results of many contract operations to determine causes of success and failure. —EDITOR.

AS A PREFACE to any discussion of contracting as a business, there are certain fundamental considerations that ought to be clearly set forth, not because there is any reason seriously to doubt their general acceptance as fundamentals but because they are often obscured by the somewhat divergent interests that the parties to a contract are likely to have in its execution.* Nor is the fact that they may be obscured at all unnatural.

The objective the owner has in mind in erecting a structure is pretty certain to be quite different from the objective the contractor has in mind in erecting it for him. Often the owner's desires are not too clearly stated. Then, too, the architects and the engineers who represent the owner in matters pertaining to the technical execution of the work have their personal interests to consider as well as the interests of the owner and the contractor.

This does not imply that any of these interests are improper. On the contrary, all of them are quite natural and on the whole quite legitimate. But owing to the business and professional relationships that have come to prevail on construction work, it is not altogether uncommon to find that some of the considerations that are fundamental in the contractor's work receive less attention than their importance to all of the parties concerned would appear to warrant.

Sales, reputation and profit

Of these fundamental considerations, the fact that the contractor's objective is profit is perhaps the most obvious. Nor is it either necessary or desirable to search for other objectives, for even though others exist, they occupy a subordinate position. All business, as that term usually is understood, is directed toward profit—construction neither more nor less than other legitimate business enterprises.

A second fundamental of contracting as a business is that it is largely a series of problems in buying and selling. The fact that the materials bought and sold are processed prior to sale and that labor and equipment are used complicates the problems that a contractor faces, but it does not otherwise alter them. To live at all, a construction organization must make sales—that is, it must obtain business. Otherwise it has no way of securing the profit that is the object of its existence. On this account, securing business is and always must be a matter of primary concern.

In the various phases of securing business, of handling it and of dealing with business associates and the public, a reputation for ability and integrity is invaluable. In this respect contracting is similar to other business activities. The confidence of business associates and of the public that a contractor knows how to handle the work he undertakes, that he will execute it accurately and faithfully—in short, that he is both able and dependable—is an asset of such value that it should be preserved at any cost.

Service only justifies profit

If any business is to enjoy more than a temporary existence, it must render a service of real value. Moreover, to preserve the business as such, those who are engaged in it must be able to perform whatever service is offered more expeditiously, better and more economically than those not familiar with the business can perform it. If this cannot be done, destructive competition is inevitable.

To state this same fundamental consideration in a little different way, there is a vital difference between performing a valuable service and performing it so well that a profit can be earned. Under proper circumstances, digging a ditch is a valuable service. But because almost anyone can dig a ditch, the service so rendered commands only a ditch-digger's wage. To obtain a profit from ditch-digging, it is necessary so to organize and so to execute the work involved that constructing ditches on an organized basis will cost less than constructing them on the ordinary basis.

Neither an individual nor an organization has any natural or innate right to a profit merely because money has been invested and risks assumed. The only right to profit that exists or that can exist over any extended period of time is the right to retain whatever margin good organization, skillful buying and intelligent selling can produce when pitted against inferior skill or pure guesswork.

Competition hazards profit

Finally, as to the fundamentals to be noted here, it is increasingly apparent that the once generally accepted theory that "Competition is the life of trade" must soon be laid aside. If unrestricted competition had proved of value to the public, it would of course be desirable to continue it. But this can hardly be said to be the case. Rather unrestricted competition has produced much obvious damage and comparatively little benefit.

The most serious and at the same time the most obvious damage that has resulted from prevailing competitive practices is found in the field of labor. Here the pressure of severe competition always tends to reflect itself in attacks on prevailing wage levels. It is axiomatic, of course, that a favorable wage scale tends to warrant a favorable selling price; but as the nature of our social structure is subjected to closer analysis, it becomes more apparent that price concessions made at the expense of labor are likely to prove socially disadvantageous. This cannot mean that a contractor is able to act independently to preserve a proper wage structure. Rather it would appear to suggest a broader application of the practice of establishing reasonable minimum-wage scales, as the federal government is now doing on much of its work, the entirely proper purpose being to protect labor from the unfortunate effects of unrestricted competition.

But labor is not the only sufferer. Unrestricted competition is even more destructive of profits than it is of wage levels. It has already been pointed out that no man has a right to a profit merely because he has invested money in a business and assumed risks in it. To obtain a real right to a profit, he

must operate so efficiently that he can obtain a remainder for this purpose out of a reasonable selling price. But whenever there is excessive competition, selling prices fall to a point that is neither normal nor reasonable, largely because custom permits the irresponsible as well as the responsible contractor to act in the establishment of price levels and on occasion, and more particularly in the materials and commodities fields, it permits bankers to force the liquidation of stocks without regard to the condition of the market for them, occasionally to its all-but-complete demoralization.

These facts and others that might be presented to reinforce them lead to the conclusion that we are approaching a time when legitimate cooperation will replace unrestricted competition. This should not and will not mean that the prices that can be obtained in the construction field will provide a profit for any and all who wish to compete for business. But it should and probably will mean that the prices established through legitimate cooperative activities will be such as to protect the contractor, who, because of the efficiency with which he handles his work, deserves a profit. And they will prevent price-shaving at the expense of labor.

Capital and profit

In any business based on buying and selling there are two obvious essentials —capital and an organization. The purpose of this organization is to plan and to effectuate the transaction of business. Capital provides the means for effectuating such transfers of ownership as are involved in the various business transactions from which the salable product results. Both the size of the organization and the amount of capital that is required depend on the volume of business to be transacted and, more particularly as to capital, on the rate of turnover.

The importance of capital and of an organization specifically designed to handle the business (as distinct from the erection) aspects of construction work can hardly be overstated. From their very nature, buying and selling involve transfers of ownership, and practically all such transfers ultimately involve compensation in money or in its equivalent—good credit. This compensation may be made when and as the goods—from the contractor's standpoint, the materials of construction—are delivered; or payment may be delayed from 30 to 90 days, and in occasional instances for longer periods. Salaries and wages must be paid when due. Incidental purchases and a few other obligations are likely to require prompt liquidation. Therefore, working capital is essential; and while a limited amount of working capital can be made to suffice if collections are prompt and materials are purchased on a 30- to 90-day basis, the fact nevertheless remains that an ample working capital is highly desirable because in a normal market the gain to be obtained from careful buying and from taking cash discounts may easily exceed any gain to be had from special efficiency in the execution of the construction aspects of the work.

The very general failure of contractors to provide ample working capital and its corollary, the tendency to take more work than the capital structure was designed to carry, are perhaps the most glaring defects that appear when construction organizations are examined from the business standpoint. Many construction firms have suffered serious financial losses solely because they have made inadequate provision for working capital. Few, if any, have become insolvent because they were oversupplied with working capital.

Besides an ample working capital, ordinary business judgment also dictates that an adequate amount of capital shall be invested in tools and equipment. But in sharp contrast with the very general tendency to provide less than a really satisfactory amount of working capital, there has been and still is a general tendency to invest too heavily in fixed assets. In part, this is due to the aggressive promotion and sale of equipment, but to no small degree it appears to be due to a widespread failure to appreciate the real earning power of well-managed working capital. Perhaps there are other reasons. In any event the really enormous inventories of but partly worn-out equipment that many contractors are carrying — inventories that show item after item that has been of service only on an occasional job—stand as mute witnesses to the fact that fixed assets have been widely over-expanded, too often to the definite depletion of working capital.

In referring to an organization as one of the essentials in the business management of construction, the reference is to the business rather than to the construction organization. The details of such an organization require no comment here. They must depend on the volume and the kind of work handled. The reference to this organization at this point has been for the purpose of focusing attention on the fact that as contracting is largely a matter of correct selling and correct buying and of the proper financing of these transactions, an organization competent to handle these matters efficiently becomes a prime requisite if success is to be attained in the construction field.

Business cycles and profit

As business is now organized in this country, it never for long maintains a uniform degree of activity. It is forever either getting better or getting worse in an endless series of ups and downs, which in many of their aspects remind one of the constant flowing and ebbing of the tides. There is and always has been a good deal of difference of opinion as to why the volume of business changes so continually and often so rapidly. But without regard to the conditions that underlie these changes—conditions with which we are in no way concerned here—the fact that the volume of business does change from year to year—even from month to month—is quite inescapable. The magnitude of these changes is much greater in some fields than it is in others. In the general field of consumer goods — foods, clothing, etc.—changes in the volume of business transacted, though of considerable magnitude, are much smaller than they are in the construction field. But even in the construction field, they are greater in some lines than in others. An examination of the indexes of current production in such lines as lumber, steel, brick and cement will show that while all of them are operating at but a fraction of normal volume, nevertheless they have by no means suffered equally in this or in any other period of depression.

These changes in the volume of business that is being transacted at any given time are quite beyond the control of individuals. So definitely is this the case that many are inclined to doubt the possibility of organizing our business affairs in such a way that they can be controlled even by as powerful an agency as a well-informed central government. This view the writer does not accept, for he feels that cooperation in business, major planning and coordination can, and indeed must, replace the unrestricted competition of the past. Be this as it may, as long as unrestricted competition persists, every considerable decrease in the volume of business will be attended by ruinous price-cutting, and every increase in the volume of business will bring increases in price. As the volume of construction work currently available (value basis) probably is rather less than a third of the volume available five years ago, it is not surprising that prices have been sharply reduced and profits very generally wiped out.

Prices and profit

One aspect of this situation deserves special comment. There appears to be a popular impression that in bad times business can be had "if the price is right." Many economists and a good many of those who write on business appear to foster this view—evidently being under the impression that when business is bad the price structure is responsible. Apparently working under this theory, a popular and widely used investors' service recently advised its readers that the railroads could and should improve their position by making general reductions in freight rates. Evidently it had never occurred to those who sponsored this advice that the volume of freight handled had fallen off because the volume of construction work was greatly diminished and that the volume of construction work was diminished because, throughout the country, more apartment houses, office buildings, factories and whatnot had been built than could be used! In a situation of

this sort, price cannot be the governing consideration. A man who now owns an apartment house that it is impossible to keep more than half occupied does not want another at any price. To have it would only serve to complicate an already wretched situation.

The point of importance here is that when the volume of business begins to fall there are fundamental reasons for its doing so that are wholly beyond the reach of the individual business man. But at least as to the construction field, in so far as this is the case, price-cutting is unlikely to prove of any advantage. Indeed it is pretty certain to be a distinct disadvantage, for sooner or later price-cutting results in wage-cutting, and wage-cutting undermines the whole economic structure to the very definite injury of the construction industry which, perforce, can only prosper when the extent of the utilization of the things (factories, power plants, office buildings, etc.) that we already have encourages the demand for more of them.

But while price-cutting is open to the criticism that it does not stimulate business because (at least in the construction field) the volume of business depends on the use that can be made of new structures rather than on the price at which they can be built, this fact can have only a general influence on the decisions of an individual contractor when he is dealing with the problem of naming a price on a given piece of work. It is axiomatic that in order to secure work at all the price named cannot be greater than the price at which others stand ready to handle it. Moreover this remains true whether the prevailing price level is high, reasonable or absurdly low. For price levels do change just as the volume of business that is being offered changes. Indeed, as already noted, the price level is directly affected by every change in the volume of business offered, for price is governed by the intensity of competition, and the intensity of competition is increased by any reduction in the volume of business and diminished by every increase in the volume of business.

The inevitable conclusion is that if a contractor desires to remain in business over an extended period, in common with other business men, he must expect to work at ruinous prices when, as at present, the price level is forced so low that profits are practically non-existant, and that he must make every effort to take full advantage of the higher price levels and the wider margins of profit that always are available when the volume of business is increasing rapidly. One of the primary functions of the contractor's business organization is to study these general business conditions and evaluate their effect on the price at which business can be obtained.

In stating the general pricing situation in this way, the purpose has been to draw attention to the relation of fundamental business conditions to the contractor's position as a business man. The effect of these conditions he can no more avoid than can a merchant or a manufacturer. All that he can hope to do is to minimize their effect by using all available information in the guidance of his judgment as to how the price structure is being affected by them. His objective is the best price that the market will afford. Nothing short of this should be accepted as satisfactory. The objective being profit, no less than this can be satisfactory, for in the long run the losses that are inevitable as the result of operations during bad years cannot be satisfactorily offset by profit obtained during good years on any other basis. In short, the contractor, like other business men, works in a field in which general price levels and prevailing margins of profit are affected by general business conditions over which he has no control. Like other business men, he must be content with the prices the market offers. But, equally with other business men, he must as nearly as possible obtain the full price that the market does offer or face insolvency.

(In the issue two weeks from now, August 3, the author will discuss the problem of securing business at the right price.)

Kansas City's Ten-Year Public-Works Plan Goes Ahead With Hand Labor

THE AWARD recently in Kansas City, Mo., of a $2,000,000 contract to the Swenson Construction Co. for a new Jackson County court house calls attention to the fact that the ten-year program of public improvements for which $40,000,000 of bonds was voted in November, 1931, is keeping to schedule. The court house will be built by normal methods, but the $4,000,000 that the city has spent in the last 1½ years went largely for hand-labor work. The significant fact, however, is that only such projects as formed a part of the ten-year plan were carried forward. There was no "made work" in the usual sense of the word. About 15,000 men were given one week's work out of three at the rate of 50c. an hour, or $4 per day. This relief work is shut down during the summer, but it is planned to start it again in the fall if unemployment remains high.

Of the total bonds, $8,000,000 are general obligations of Jackson County, and $32,000,000 are general obligations of the city. So far as the city was concerned, it was stipulated that not more than $3,200,000 should be spent in any one year. All bonds so far issued have been sold in the open market at a premium.

Among other things, the city's bond issue was planned to cover a 4½-million-dollar auditorium, 3½ million dollars of water-distribution work, 1½ million dollars of sewers, 2¾ millions of boulevards, 1 million dollars for stream regulation on Brush Creek and a like amount on the Blue River, a 4-million-dollar city hall, a ¾-million-dollar stadium and a ½-million-dollar market. According to Matthew S. Murray, city director of public works, no priority was set up for these projects. The original intention was to build them with normal methods, but when employment needs became so urgent hand labor was substituted and those projects were chosen to go ahead that would provide the maximum amount of this type of work.

The excavation for the city auditorium across the street from the present Convention Hall was made by hand at an expenditure of $1,500,000. About $2,200,000 was spent on sewers and water mains. $1,000,000 was spent on Brush Creek and the Blue River. Through County Club Plaza and beyond 5 miles of Brush Creek was provided with a 70-ft.-wide channel, riprapped banks and in some places a paved floor. In other places this creek and others were entirely inclosed in concrete boxes. At the airport $350,000 was spent in riprapping the bank of the Missouri River and in building a post office and a large hangar. Considerable street work was done, the most notable being the widening, out of solid rock, of Beardsley Boulevard, which leads down the side of a cliff to the lower level of the 12th St. viaduct.

Every type of man that applied for work was given a job if he could prove he was in need. So far as possible, men were given jobs with which they were familiar, but a great many applicants had never done any kind of manual labor.

Under Mr. Murray, the nucleus of the city's supervisory organization consisted of a general superintendent of labor who placed the men and shifted them from job to job, and a general superintendent of construction who supervised actual operations. There were superintendents on each job, and seven men of the city's office engineering force acted as inspectors and field engineers. The city owned no equipment, so that the few pieces that were required were rented as needed. The equipment owner furnished all gasoline and oil as well as the operator.

By the above procedure Kansas City has been able to carry its public-improvement program forward in the face of discouraging conditions. While the work is costing more than it would if normal methods were used, the net effect is a substantial gain, for breadline expenditures are reduced and permanent structures are provided.

Driving a 4,230-Ft. Tunnel in Yosemite National Park

Tunnel solves difficult highway location problem on major approach route—Driving procedure modified as work progresses to increase daily advance from 5.6 to 18 ft.—Ventilation system installed

By Charles S. Moore

Assistant Highway Engineer, U. S. Bureau of Public Roads, San Francisco, Calif.

IN THE MODERNIZING of a major highway approach route into Yosemite National Park a 4,230-ft. tunnel provided the solution for a difficult relocation problem. The project has been carried out by the U. S. Bureau of Public Roads for the National Park Service and involved 28 miles of heavy mountain grading in addition to the 0.8-mile bore. By the new location

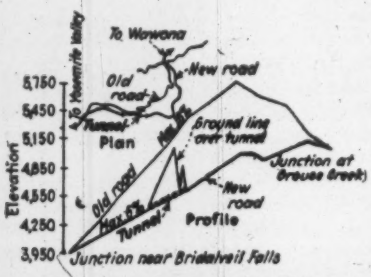


Fig. 1—Long highway tunnel and relocation of road eliminates several miles of heavy grades on Yosemite Park highway.

the distance and curvature are reduced, the maximum grade is decreased from 18 to 6 per cent, and the summit is lowered about 650 ft. Although the grading operations were heavy, they did not develop any outstanding features, and the principal construction interest centers in the driving of the long vehicular tunnel.

The Wawona approach route to the Yosemite Valley is an old one, the original private toll road having been built for a stage-coach line in the 1880's. Subsequently the road was improved by the National Park Service, but the location precluded improvements to satisfactory standards. By 1926 heavy motor traffic was using this route, although it was still practically a one-way road with sharp turns and steep grades. In that year the National Park Service requested the U. S. Bureau of Public Roads to undertake a relocation to bring the route up to modern standards. By 1930 the 28 miles of new location had been graded except the section from the valley floor to Turtleback Dome.

This last section presented the most difficulties. After careful study of alternate locations it was determined that the securing of satisfactory curvature and grades required a 4,230-ft. tunnel through solid granite. Contract for this section, including the tunnel, was awarded in November, 1930. Tunnel items amounted to 60 per cent of the total, and the bid prices were:

4,230	lin.ft.	tunnel excavation.....$80
500	lin.ft.	14x14-ft. gallery excavation. 30
530	lin.ft.	7x6-ft. gallery excavation.. 20
500	lin.ft.	concrete tunnel lining..... 50

Tunnel design

The tunnel is of semicircular section with a 14-ft. radius on a 5-ft. springline. An additional 12-in. bottom excavation provided for a 5-in. backfill and 7-in. concrete pavement. The paving is 24 ft. wide, corresponding to the shoulder width of the open roadway, with 1-ft. curbs and a 3-ft. walk on one side.

The net tunnel section is 28 ft. wide, with a maximum height of 19 ft. at the crown of the arch. This section represents 16.6 cu.yd. of material, solid measure, per linear foot. The formation is solid granite and in the main very uniform. Alignment is tangent on a sustained 5 per cent grade. A large parking area is provided at the lower portal, which permits a wonderful panorama of the Yosemite Valley.

The lower portal is a solid granite wall and did not require any portal construction except stripping of the loose overburden. Material at the upper end is loose and blocky, and a portabl structure was necessary. Horizontal side galleries or adits were constructed from the main bore to the face of the cliff for natural ventilation and the installation of ventilating equipment. Small ones, 7x6 ft., were driven about 1,000 ft. from each end, and a large one, 14x14 ft., was driven about at the midpoint. This adit was later enlarged to full tunnel section. Excavated material was used for fills on the highway and the parking area below the tunnel, necessitating the start of work at the lower portal.

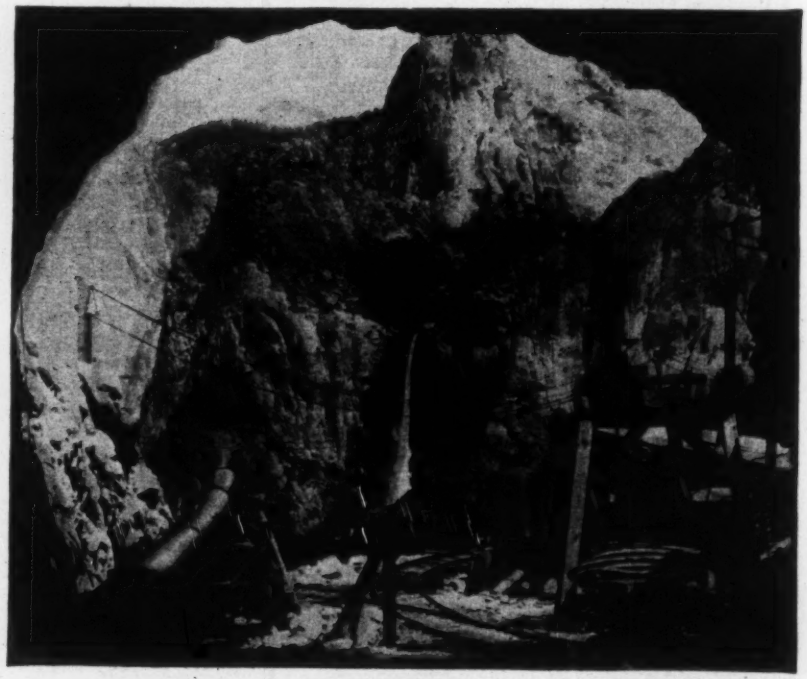
Following award, the contractor set up a 175-man camp and began the grading of a pioneer road, within final construction stakes, to the lower portal. After a few weeks it became apparent that this pioneering would require at least two months, and to get tunnel operations started the contractor decided to construct a tramway to the lower portal from the old road above.

A 1,000-ft. tramway was built, and a double-drum electric hoist was used to operate a converted dump-car on the tramway. A tractor skidded the equipment up the old road to the tramway. The portal was stripped, and a rock face large enough for a 10x11-ft. center top heading was opened.

Tunnel driving

The most interesting feature of tunnel-driving operations is the gradual

Fig. 2—View from lower portal of tunnel. Bridal Veil Falls and sheer cliffs of Yosemite Valley are in background.



change and improvement of procedure. The heading and bench method was used throughout, but the size and shape of the section was such that previous tunnel projects provided little in the way of precedent. For mucking, a standard air-driven, crawler-mounted shovel was used with short boom and sticks. This was an old rig, badly worn, and proved to be a source of delay as the work progressed.

Gasoline-powered trucks were used for hauling until the face had been advanced 100 ft. Then tracks were placed and dump cars were used, being operated through a cable and sheave by a 25-hp. electric hoist placed just inside the portal. Later two 12-ton battery locomotives and twelve 5-cu.yd. side-dump cars were added. A trolley wire was used outside and for the first 2,000 ft. inside the tunnel, as it was impossible to keep batteries charged for a full shift. Use of the trolley permitted charging the battery while the locomotive was in use, and a battery could be operated eight to twelve hours without being replaced for charging.

Three-car trains were used. The main, or loading, track was kept on the left side of the tunnel and extended to the front of the shovel. A spur track 150 ft. long extended up to the rear of the shovel and was used for empties. The locomotive pushed the three empty cars up to the shovel, and a cable attached to an air hoist on the rig was fastened to the one next to the locomotive. The head car was picked up by a "cherry picker" and swung to the other track by a boom attached to the shovel. A cable attached to another hoist was secured to this car, and as soon as it was loaded it was dropped in the clear and another empty car was swung alongside. When three cars were loaded the locomotive coupled on and removed the train.

The bunkers were of unusual design, being built in five small units of about one carload each. This design allowed for segregating material and tied up little bunker capacity if large rocks jammed. A grizzly was built into one unit to separate fine material for topping. Five to six trucks hauled from the bunkers to the fill, and a tractor and bulldozer were used for spreading.

The original drilling plan called for the 10x11-ft. top center heading to be advanced as rapidly as possible. Behind this heading four drilling machines, swung on cross-arms from a horizontal bar, drilled parallel ring holes 3 ft. apart to break out the remaining portion of the tunnel above the bench level. In shooting the 20- to 23-ft. bench rounds six or seven rings of top holes were fired in conjunction, using delay detonators to secure proper sequence (Fig. 3). Under this plan the progress was not satisfactory because of interference between heading and ring-drilling and the difficulty in advancing the heading as fast as the bench could be broken. The tunnel was being advanced only 335 ft. at a daily average of 5.6 ft.

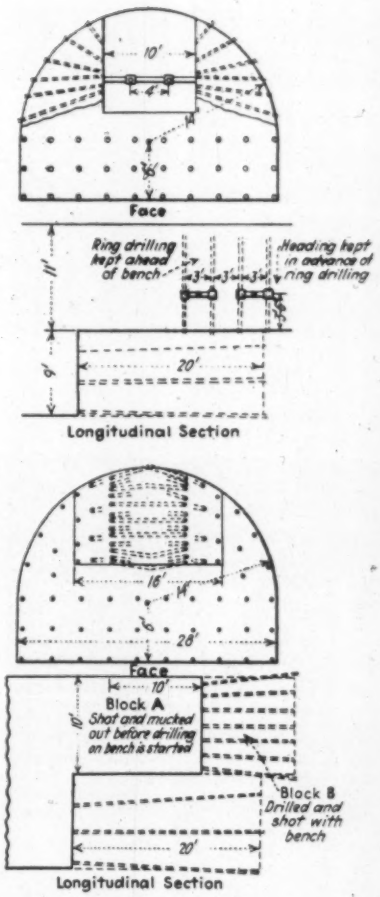


Fig. 3—Drilling diagrams of tunnel driving. Above: original system, which used ring-drilling from center top heading. Difficulty resulted from interference and because heading could not keep up with progress made on bench. Below: final drilling diagram, showing heading being advanced two rounds per cycle and elimination of ring-drilling. Drilling in the heading was done from columns, and for the bench holes horizontal bars were used.

As an improvement in driving procedure the width of the heading was increased to 18 ft. and the ring-drilling was eliminated. Columns were set up in the heading, and the machines were swung from cross-arms, drilling holes varying from 13 to 19 ft. deep. Bench holes, drilled roughly parallel to the center line, were the same depth as heading holes. Horizontal bars were placed across the tunnel, one 1 ft. above grade and the other at the spring line. Clamped to these bars was a vertical curved bar, free to slide horizontally, paralleling the curve of the tunnel section and extending up into the section of tunnel beside the heading. Machines were swung from this bar to drill the wing sections. Bench and heading holes were loaded and fired simultaneously, delay detonators giving proper firing order. Thus the tunnel was advanced 638 ft., with a daily average of 13 ft.

The contractor decided that satisfactory progress was not being made, and a new drilling and shooting plan was adopted. Under the third plan two 10-ft. heading rounds and one 20-ft. bench round were drilled and fired in one cycle of operations (Fig. 4). An 8x16-ft. heading was used, kept from 6 to 20 ft. ahead of the bench. Later this heading was deepened to 10 ft. The drilling set-up was the same as under the previous plan except that heading holes were drilled 12 to 15 ft. deep and bench holes 22 ft. Usually four drilling machines were used on the heading and eight on the bench. A total of 84 to 100 holes, depending on the rock, were used for the entire face.

Delay exploders, numbered 1 to 14, were used in firing. Cut-holes, the first row of relievers and most of the bench holes were loaded with 60 per cent gelatin powder, the remainder with 40 per cent. The heading cut-holes exploded first, followed by the first relievers, breast and lifters in order, with bench-holes being fired from top to bottom after all heading shots were fired.

Drilling machines, air hose and bars were taken into the tunnel on flat cars, all ready for installation. Drill steel was taken in on flat-cars and racked, by lengths, back of the drillers. Leyner-type drills were used. About 1,000 pieces of drill steel, from 3 to 23 ft. in length, were required every 24 hours. Drill bits varied from 3 in. on the 3-ft. starters to 1⅝ in. on the 23-ft. steel. Each piece of steel was sharpened after being used once.

The driving sequence for this plan was as follows: Starting with the muck cleared away and the heading 16 to 20 ft. ahead of the bench, a heading and bench crew were sent in together, the miners drilling simultaneously on both (Fig. 5). As soon as the drilling and loading were completed, the heading and bench were fired. These operations required about six hours. After this shooting the heading was only 6 to 10 ft. ahead of the bench. After waiting an hour for the air to clear, the mucking crew went to work.

The small amount of loose rock on the heading was cleared away and drilling on the heading was resumed while the mucking rig went to work below. Another set of holes, 12 to 15 ft. deep, was drilled and loaded, the mucking rig moved back, and the heading shot again. This drilling and mucking required about eight hours. After waiting another hour for the smoke to clear, the second mucking crew went to work and cleaned up all loose material. After this second shooting the heading was back to original relation to the bench, and the cycle was completed. The short heading rounds resulted in a remarkably small amount of overbreakage.

With this system working smoothly, the daily advance was increased to 16 to 20 ft. Powder requirements were less than 7 lb. per cubic yard of material. Split shifts were required in this driving schedule, but no laborers were permitted to work more than eight hours in any calendar day. Forced ventila-

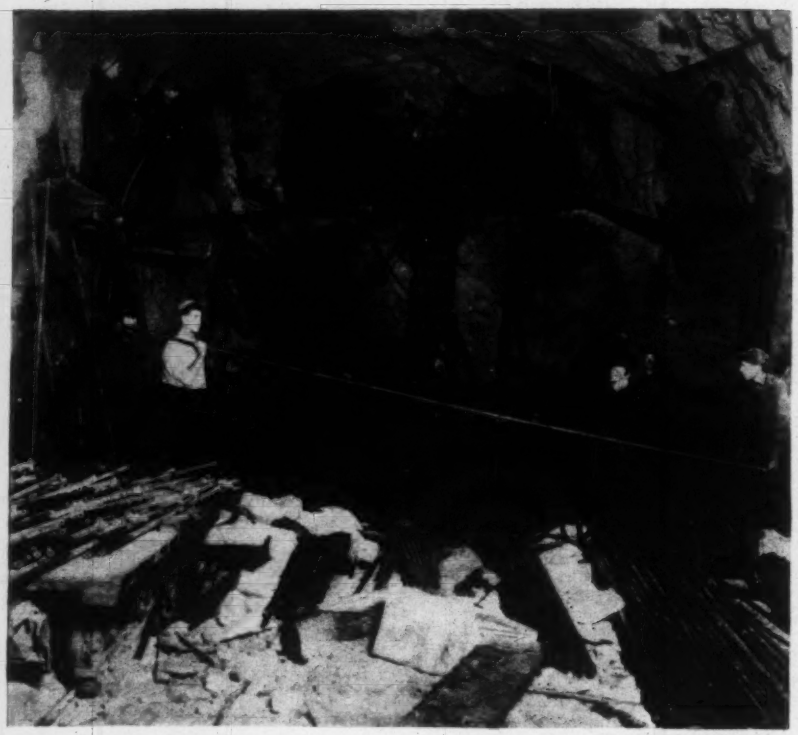


Fig. 4—Operations at the face, using the final system of driving, with both heading and bench-drilling in progress. Note the curved bars used in drilling wing holes.

tion was used throughout the job. A blower driven by a 75-hp. electric motor was set up outside the portal, and a 24-in. metal-pipe air line was carried as close to the face as feasible. Two stationary 1,000-c.f.m. air compressors, each driven by a 200-hp. electric motor, were set up at the portal.

Concrete lining and paving

Only 745 ft. of the tunnel required lining. The concrete lining is 18 in. thick at the spring line, 15 in. at the quarter point of the arch and 12 in. at the crown. Reinforcing steel, 1½ in. from the inside wall, consists of ¾-in. square bars spaced 12 in. Collapsible wooden forms in 10-ft. sections were used.

The mixer discharged directly into the concrete gun, and the feed pipe from the gun was carried over the top of the forms and ended in vertical steel chutes, which were carried down the inside of the forms to within 5 ft. of the bottom. These chutes were in sections and were removed as the concrete built up. The entire lining plant was mounted on wheels on a central track. Tampers were used, except in the crown of the arch, and in addition air vibrators were used on the face of the forms.

At one point a 105-cu.yd. block of rock that came out of the roof of the tunnel made a cavity with a high point 17 ft. above the arch. Under this cavity the lining thickness was increased to 18 in. Three pipes, extending to the top of the cavity, were placed before the lining was poured, and later the entire cavity was pumped full of wet sand. This sand supported the rock and formed a cushion for the lining.

A sand cushion 5 to 6 in. thick was placed on the tunnel floor by the tunnel contractor, and a 7-in. concrete pavement was placed under a later contract.

Ventilation and lighting

Ventilation adits were driven from the tunnel to the face of the cliff at the quarter points and the center. The former are 7x6 ft. The upper adit is 65 ft. long, and the lower is 382 ft. The central adit is 502 ft. long and was enlarged to full tunnel section to provide a greater area for ventilating. All adits have a downgrade of 1 per cent from the tunnel to assure drainage.

During most of the year traffic through the tunnel will not be heavy enough to require forced ventilation, but on holidays and other peak traffic days the number of vehicles will require the augmenting of the natural draft. Accordingly, three fans of the disk or propeller type have been installed at the center adit. Each is driven by a variable-speed, 25-hp. electric motor. The fans deliver 300,000 cu.ft. of air per minute, exhausting through the adit. Provision is made for reversing the direction of flow if necessary.

The fans are automatically controlled by carbon monoxide analyzers and recorders located at strategic points in the tunnel. The regulation provides that full fan capacity will be used when the carbon monoxide content reaches 4 parts per 10,000. The volume of ventilating air varies down to one-half the capacity of one fan when the concentration is less than 1 part per 10,000. If the concentration reaches the danger point, semaphore signals rise at each end of the tunnel, red lights show and a warning bell sounds.

The electrical lighting system includes twelve 6,000-lumen, 130 4,000-lumen and thirteen 75-watt lights. A room cut into the rock off the central adit houses the switchboard and electrical equipment.

L. I. Hewes is deputy chief engineer of the U. S. Bureau of Public Roads, C. H. Sweetser is district engineer, and Levant Brown is senior highway engineer in charge of national park roads. T. M. Roach was resident engineer on the tunnel project. D. Harrington and S. H. Ash, of the U. S. Bureau of Mines, were consultants on the ventilating and safety features. Col. C. G. Thomson is superintendent of Yosemite National Park.

The main tunnel contract was carried out by A. C. Goerig, Seattle. Goerig and Dahlberg, Seattle, had the contract for enlarging the central adit. Paving and part of the concrete lining was in the contract awarded to the United Concrete Pipe Corp., Los Angeles. Ventilating and electrical installations were covered by several small contracts.

Arch Dam Study Completed

Completion of the arch-dam investigation that has been carried on during the past ten years under the direction of the Engineering Foundation, New York, is announced by the Foundation. The study was begun in 1922 with Prof. C. Derleth, Jr., of the University of California, as chairman. He was succeeded by Prof. Charles D. Marx, of Stanford University, in 1926. Other members of the committee were Fred A. Noetzli, Paul Bailey, George S. Binckley, H. W. Dennis, Alfred D. Flinn, D. C. Henny, M. M. O'Shaughnessy, H. Hobart Porter, J. L. Savage, F. E. Weymouth and Silas W. Woodard. Alternates were R. E. Davis, Julian Hinds, Ivan E. Houk and Wynne Meredith.

Seventy-five organizations contributed more than $125,000 in cash, and with contributions of services and materials the Engineering Foundation estimates that the total investment in the work exceeds $200,000. The committee built the Stevenson Creek Dam near Fresno, Calif., an arch dam 60 ft. high, solely for experimental purposes. Models of the Stevenson Creek Dam were tested at Princeton University and in the laboratory of the U. S. Bureau of Reclamation at the University of Colorado to check test results against results obtained on the Stevenson Creek Dam. Further extensive tests and observations on other dams were carried out by individual members of the committee.

NEW PLANS FOR THE MISSISSIPPI

Special River Problems Studied by Models

Fifth of a Series of Eight Articles

Tests of Bonnet Carré railway embankment and floodway, of a pilot channel for the Boeuf floodway and of the operation of the New Madrid floodway yield information of general interest

MOST of the experiments at the Waterways Experiment Station have been to determine facts relating to specific improvements completed or being planned. The results in many instances have little interest beyond the solution of the immediate problem. For example, at Starved Rock lock and dam, on the Illinois River, detritus was forming bars in the channel below the lock. A model study indicated the source of this bar material and pointed to the remedial structures necessary. So with many other experiments the determinations had only local significance.

In reviewing the specific works investigations of the laboratory, only those having general interest or giving results of general application are considered. These, without reference to the order of their importance, are as follows:

Scour of railway embankment

Prompted primarily by the controversial question of types of railway structure across the Bonnet Carré floodway, but also having in mind railways in flood and backwater areas, a series of reduced and full-scale tests of overflow effects on railway embankment has been conducted. The tests were in order of time and roughly in two series, the first of which was described in *Engineering News-Record*, June 11, 1931, p. 970. From these tests the conclusion was indicated that a rock sill 6 in. higher than the top of the rail and placed on the downstream side of the track would most effectively protect the track and embankment from scour by overtopping floods. The final and best design of embankment structure determined was that shown by Fig. 1.

With a full-size model constructed as shown by Figs. 1 and 2, the second series of tests was begun in February, 1932. The first eleven runs indicated complete effectiveness of the protective sill. No more regularly scheduled tests were made, but with no change of any kind being made on the structure, it was later subjected to flows as follows:

	Hours
Carried forward	124
June 15, 1932	9
Dec. 12, 1932	12
Dec. 16, 1932	16
Dec. 27, 1932	16
Jan. 18, 1933	7.5
Feb. 7, 1933	12
Feb. 15, 1933	13.5
Total	226.

After 133 hours of tests no permanent damage of any kind had resulted. There was no movement of ballast or failure of riprap at any time. In the cases where ballast was removed from between two adjacent ties, it was always retained between the lower rail and sill in such a manner that it could be readily salvaged and returned to place. The tendencies to greatest damage are on rising and falling stages when water is flowing thinly over the rails, and at high sustained stages no damage of any kind occurs. The experiment therefore was more rigorous than is indicated by the figures for duration of flow.

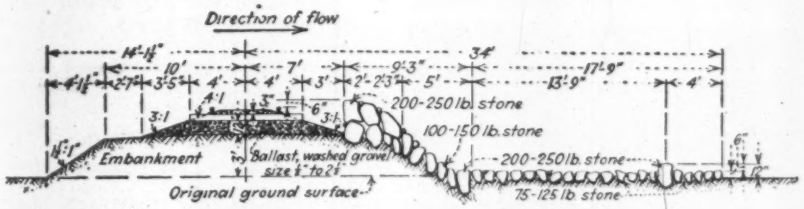


Fig. 1—Railway-embankment protection shown by full-size model tests to be safe under severe flood conditions.

In point of fact, the embankment was subjected to what amounts to about twenty overflows. Fig. 2 shows the condition of the embankment after the rain of Feb. 15, 1933, when such flow occurred over the spillway of the storage reservoir as to produce surface velocities of 22 ft. per second over the rails. It will be noted that no material damage could be detected in movement of the ballast, although the banks of the creek had been eroded and caved, and all bridges had been carried away by the strong current.

Pilot channel studies

The possibility of narrowing the main discharge of flood waters through floodways such as the Boeuf and Atchafalaya, by excavating a pilot channel which would enlarge by scouring, was exhaustively investigated. A model of the Boeuf floodway was used for general determinations, and various flume models were used to determine soil erodibility and transportation. The

Fig. 2—Test embankment, constructed as shown by Fig. 1, as it appeared after 226 hours of free overflow. No ballast was carried beyond the downstream wall

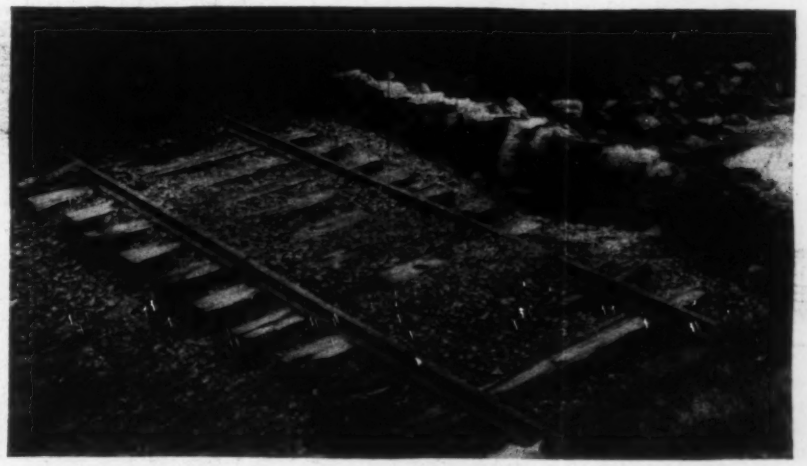


Fig. 3—Model of pilot channel through Boeuf floodway. Dark areas are brush growth simulated by Spanish moss; white areas show flood deposits of sediment (slaked lime).

results of the erosion and transportation tests have been summarized in the previous article on general investigations.

To determine specifically the action of a pilot channel through the Boeuf floodway, a 65-ft. model was constructed to scales of 1:10,000 horizontal and 1:100 vertical. Fig. 3 is one view of the model. The pilot channel was molded 300 ft. wide and 30 ft. deep, following the presumably lowest elevation and about the middle line of the floodway. The model appurtenances were of the usual order previously described. The earth relief of the floodway, wooden areas, etc., were carefully reproduced from recorded surveys and aerial-survey mosaics. Streams in the floodway were provided with separate flow.

As the purpose of the tests was primarily to ascertain sediment movement, direction of overbank flow, backwater influences, etc., the model was of virtually fixed-bed construction. Separate tests determined the best surfacing material to be a 1 cement: 3 finely sifted sand, with the least necessary water to secure plasticity. For tracing direction of flow the water was stained with permanganate of potash. Slaked lime was found to give the best results as a sediment material, a great advantage being its visibility after deposition. The over-all results of the tests were briefly:

1. At bankful flow throughout, the pilot channel carried all but unreasonably heavy introductions of sediment, but over prolonged periods the channel bottom gradually silted up, resulting finally in overflow at points of lowest banks.

2. At bankful stage meeting backwater at about Monroe, silting appeared at all low places in the backwater area; all marked silt deposits in the vicinity of the channel were accompanied by pronounced shoaling within the channel; merging with the backwater, the flow began to abandon the pilot channel and follow other streams until most of it was in other streams; sediment deposits were pronounced where diversion took place.

3. At flood stage the silting occurred in the upper reaches of the floodway; in the lower reaches the identity of the pilot channel flow disappeared, and the flow was in a broad stream.

4. At superflood stage the pilot channel served no function whatever, quickly silted and ceased even to guide the stream.

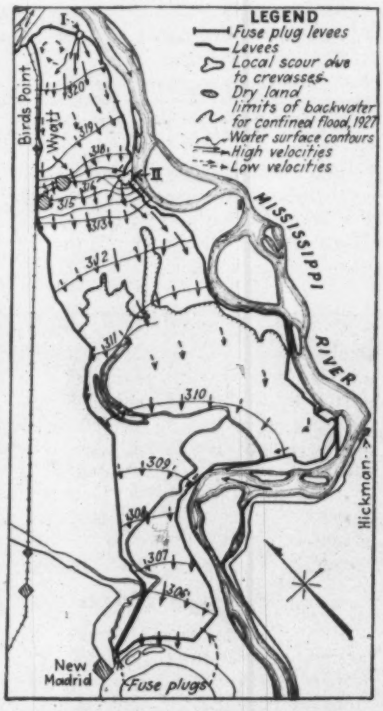


Fig. 4—Model map of New Madrid floodway, showing crevasses, backwater limits, current velocities and water-surface contours resulting from a simulated 1927 flood.

In conclusion, the test runs indicated no successful results from a pilot channel at flood stages and little expectation of its enlargement by lesser within-bank discharges.

Action of New Madrid floodway

Protection of Cairo, Ill., as provided in the flood-control project, is by a floodway formed by a setback levee from Birds Point to New Madrid, Mo. The river-bank levees except for two fuseplug sections have been raised to project height. With a stage of 55 ft. at Cairo, the river overtops the upper fuseplug and finds escape through the floodway, keeping the flood crest below the danger point at Cairo. This floodway (Fig. 4) has been completed.

Model tests were made to determine the effects of the floodway, assuming various past flood conditions, on gage heights, backwater limits and sediment deposition, and to record surface slopes and velocities of flow in the floodway. The general results were in brief as follows:

The following table of gage heights at Cairo shows the comparison of floods confined in the levee system as of 1929 to the same floods when the floodway is functioning:

Highest Flood of	Confined	Under Project Plan
1882	56.1	53.8
1883	56.3	53.9
1884	55.9	53.6
1911	57.9	55.9
1913	58.9	57.2
1927	58.3	56.7
Mean Flood ..	57.3	55.5

Discharge through the floodway depends for a large part upon entrance conditions and upon the effectiveness of the levee fuseplug. Although tests showed the discharge through the floodway to increase slightly with stage, the net drawdown on the model measured at Cairo remained practically the same during all the floods, the increase in diversion during the higher floods being counteracted by the increased effect of backwater from the confined flood. In the case of floods sufficiently high to overtop the fuseplug levee after forming two crevasses, the drawdown due to the floodway was found to increase with the magnitude of the discharge.

Following a crevasse at one point, a second crevasse may occur unless the drawdown is sufficient to prevent further overtopping of the fuseplug levee. In such an instance the floodway may continue to operate at part capacity throughout the duration of the flood. With the first crevasse occurring at I (Fig. 4), the diversion will be less than in the case of a downstream crevasse, but the minimum lowering of main river stages along the fuseplug levee will be nearly the same.

The head lost in flowage between the river and the floodway will materially reduce water-surface elevations in the floodway area under elevations in the river directly opposite. This is because

the water flowing through the crevasses will attain high local velocities and will assume a steep gradient until flow becomes distributed. At the crest of the 1913 flood the head lost through the upper crevasse would have been about 2 ft., and through the lower crevasse about 4 ft. That is, the water-surface elevations in the floodway except at the crevasses would have been about that much lower than in the river at points directly opposite.

Outside the immediate vicinity of crevasses high velocities will not occur in the floodway. In the model the tendency of flow was to spread out over the entire area and become uniformly distributed within a short distance of the fuseplug. Velocities as high as 8.5 ft. per second were observed in the crevasse area. Over the low ground a maximum of about 6 ft. per second was observed, while velocities across the ridge were less than 4 ft. per second. South of the railroad the velocities ranged between 3 and 4 ft. per second. Still further south they were much lower. In Fig. 4 the solid flow arrows indicate velocities in excess of 2 ft. per second; broken arrows, less than 2 ft. per second.

Except for a belt of land extending along the inside of the upper fuseplug, the land lying in the floodway area will suffer no permanent damage from the periods of inundation. Within a half-mile below a crevasse in the fuseplug, almost any kind of damage is likely to occur; within three miles below a crevasse in the fuseplug damaging sand deposits may occur.

Action of Bonnet Carré floodway

Several experiments were conducted in the spring of 1931 for the purpose of determining effects resulting from the operation of the Bonnet Carré spillway. These experiments were designed to show: (1) methods of treating the lower ends of the dredged borrowpits to prevent erosion: (2) determination as to whether erosion would occur at the upper ends of the borrowpits, assuming high velocities to be produced by the influence of forested areas in concentrating flow at these points; and (3) a determination of velocities and directions of flow that may be anticipated in the floodway during the operation.

For these several purposes models of different design and scale were constructed. The first, which was used for determining methods of treating the lower ends of the dredged borrowpits, was built to a horizontal scale of 1:1000 and a vertical scale of 1:120, this vertical distortion being necessary to insure turbulent flow. A proper n ratio was obtained for overbank areas by a gravel covering, while an adjustable tailgate provided a means of maintaining the lake level.

In addition to this, an erodible model was constructed to a scale of 1:100, undistorted. The latter included only a section of the area between the ends of the borrowpits and the lake, and this overbank covering was simulated by the use of Spanish moss.

Supplementary to these models a wooden flume was set up for the purpose of testing the actual soil taken from the floodway and its resistance to erosion. Directions of flow were determined in the models by injecting a solution of dye into the current and observing its travel through the floodway. It was observed that variations in the lake level had little effect on the lines of flow, but velocities through the proposed trestle were slightly increased by a lower lake level. This latter fact, however, was not as great as might have been expected, due to the smoothing out of the flow by the forested areas between the trestle and the lake shore. Under the first proposed method of treatment no additional dredging at the ends of the pits was required. Water coming from the pits was dispersed over 60 per cent of the length of the trestles, and all drift coming down the pits was stopped by the projecting band of forests between the dredge channel and the trestle. Other proposed methods of treatment produced a nearly equal dispersion of flow but indicated the disadvantage of permitting drift to come through and lodge against the trestle.

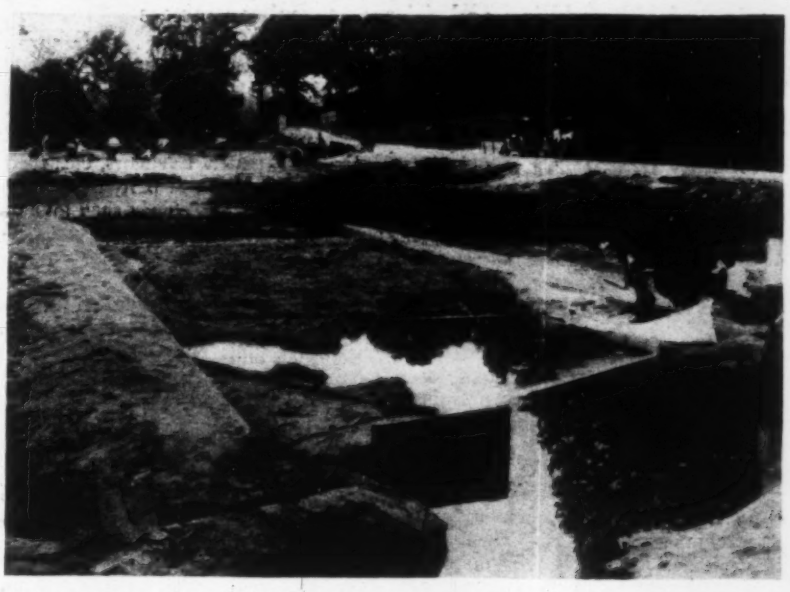


Fig. 5—Model of Bonnet Carré floodway showing wooded area, dredge-cut borrowpits for levees, spillway and railway crossings (fine white lines) all being observed under flood stages.

Conclusions of tests

From the 1 to 100 scale model it was determined that no erosion would occur around the trestle in any case; and the flume tests indicated that native soil would withstand greater velocities than could possibly be produced in the floodway. The result of the first part of this experiment was to indicate a definite method of treatment that would involve no further dredging and would succeed in dispersing the spillway flow over a larger area. The directions of flow obtained and velocities determined by experiment, together with the results of the flume tests, showed that little fear should be held as to the possibility of serious erosion occurring.

Experiments similar to those just cited were subsequently conducted to determine if erosion would occur at the upper ends of the borrowpits, and, from the tests made, it was concluded that even with high velocities the materials at the heads of the borrowpits will effectively resist erosion. Assuming that the railroad are placed on the fills for a distance past the head of the pits, it is even more unlikely that undercutting of the pits will occur.

Following the experiments just enumerated, tests were conducted on the 1:100 undistorted model, which represented in detail a large section of the spillway over which one of the railroads passes. These experiments were designed to show the effects of flow through the trestle part of the proposed railroad bridge and to indicate methods necessary to insure free flow of water through the structure without production of excess scour around the piling. Supplementary to this, a number of tests were conducted in the floodway itself, piles being driven in the native soil and water made to flow around them by releasing the impounded water from within one of the borrowpits. The result of all the experiments was to show that relative low velocities would be produced within the floodway; to indicate directional lines of flow; and to demonstrate that the native soils would be able to withstand erosion by velocities very much greater than those possible of production within the confines of the floodway.

Code of Fair Competition for General Contractors

Industry code submitted for approval to National Recovery Administration by general contractors includes "local-agreement" minimum wage, 150-hour month, outlawing of bid peddling and fairness to subcontractors

FULL TEXT is given below of the code of practice and fair competition submitted July 15 to the National Recovery Administration by the Associated General Contractors of America. This code, as presented, is basic for the general contracting industry, and supplemental codes for building, highway, public works and railroad construction will be developed and filed after the basic principles have been approved. It is expected that it will be necessary further to amplify such supplemental codes to take care of local and regional problems. In brief summary the principal provisions of the code are as follows:

Employees shall have the right to organize without interference and bargain collectively through representatives of their own choosing. No one shall be compelled to join a company union.

General contractors shall pay wages not less than the minimum established regionally or locally by agreement between employers and employees. General contractors shall require subcontractors to adhere to established wage standards.

Labor shall not be permitted or required to work more than 150 hours a month.

Employers shall see that proper safety standards are maintained.

General contractors shall pay to subcontractors, material vendors, etc., their proportionate share of partial payments made by the owner. They shall give or accept no rebates. They shall not permit subcontractors or material vendors to finance their accounts.

Trade practices recognized as fair include guaranteed price, cost of work plus a fee, unit price, lump sum and other contractual methods not inimical to the public interest.

Fairness must be observed in bidding. To establish parity in bidding as to wages prior to the establishment of wages rates under the Recovery Act, rates should be established by competent authority and be the basis of all bids.

General contractors shall not engage in bid peddling or other unfair practices, and shall refuse to deal with persons who have not complied with the code of fair competition.

A national industrial-control committee for general contractors is established to insure that the code is observed throughout the industry. The text of the code follows.

Text of the Code

The Associated General Contractors of America, a national trade association representative of general contractors throughout the United States for more than fourteen years last past, pursuant to the purpose of the general contractors of the construction industry to cooperate with the President of the United States in effectuating the policy declared in Title 1 of the National Industrial Recovery Act, does hereby recommend and submit for approval pursuant to Section 3 of said title the following Code of Fair Competition and plan for its administration for all construction work in so far as it pertains to general contractors:

Article I

(a) This national trade association of general contractors affirms that it imposes no inequitable restrictions on admission to membership therein, and is truly representative as a national trade association of the general contracting industry.

(b) This code will not promote monopolies or eliminate or oppress small enterprises, and will not operate to discriminate against them and will tend to effectuate the policy of said Title 1. It is expressly recognized that the President of the United States may, as a condition of his approval of this code, impose such conditions (including requirements for the making of reports and the keeping of accounts) as may be expedient in the furtherance of the public interest for the protection of consumers, competitors, employees and others, and may provide such exceptions to and exemptions from the provisions of this code as the President of the United States in his discretion deems necessary to effectuate the policy herein declared.

Article II—Declaration of Policy

In order to induce and maintain the united action of labor and management under adequate governmental or private sanctions and supervision, to eliminate unfair competitive practice and to advance the public interest, to reduce and relieve unemployment, to improve standards of labor and living and otherwise rehabilitate the general contracting industry and effectuate the policies set forth in the National Industrial Recovery Act, this code of fair competition governing the furnishing of construction services by the general contracting industry is adopted.

Article III—Definition of "Contractor"

When used in this code, the term "general contractor" is any person, partnership, company, association, corporation or agency which contracts to supervise, coordinate and/or execute the work of constructing an improvement substantially in its entirety, as is embraced in plans and/or specifications. Any person, firm, partnership, agency, company, association or corporation undertaking to direct, supervise, coordinate and/or execute construction work whether by formal contract or otherwise in excess of $1,000 in the aggregate shall be subject to compliance with these articles and code as fully and completely as shall any person, firm, partnership, agency, company, association or corporation known or designated as a "general contractor" in the construction industry.

Article IV—Labor Relations

Section 1. Labor Conditions—In accordance with the requirements of the National Industrial Recovery Act:

(a) Employees shall have the right to organize and bargain collectively through representatives of their own choosing, and shall be free from the interference, restraint or coercion of employers of labor, or their agents, in the designation of such representatives or in self-organization or in other concerted activities for the purpose of collective bargaining or other mutual aid or protection.

(b) No employee and no one seeking employment shall be required as a condition of employment to join any company union or to refrain from joining, organizing or assisting a labor organization of his own choosing.

(c) Employees shall comply with the maximum hours of labor, minimum rates of pay and other conditions of employment, approved or prescribed by the President.

Section 2. Minimum Wages—(a) A general contractor shall pay wages not less than the minimum rates which are established regionally or locally by mutual agreements between truly representative groups of employers and employees, and approved by the President, as provided by Section 7 (b) of the National Industrial Recovery Act. Where such rates are not so established, the minimum rates of wages determined in each of the several States under authority of Section 204 (c) of Title II of the National Industrial Recovery Act shall be used as the minimum rates for all kinds of construction work.

(b) A general contractor shall require subcontractors and other agencies requiring the services of laborers or mechanics on the site of the work to pay not less than the established minimum rates of wage.

(c) A general contractor shall not resort to the use of what is known to the trade as "piece work" or similar contractual relationship in his employment of labor, when tending to defeat the spirit and purpose of Section 7A-3 of Title I of the National Industrial Recovery Act.

Section 3. Maximum Hours—

(a) A general contractor shall not permit nor require any individual directly employed on any construction project to work more than 150 hours in any one month, so far as practicable and feasible; *except* those in executive, administrative and supervisory positions, and *except* as a lesser number of hours is required by Title II of the

National Industrial Recovery Act relating to public works and construction projects thereunder.

(b) A general contractor shall require all subcontractors and other agencies requiring the services of laborers or mechanics on the site of the work to observe strictly the maximum hours provisions established herein. Nothing herein shall be construed as preventing voluntary agreements establishing a lesser maximum number of hours as provided in the National Industrial Recovery Act.

Section 4. Labor Welfare—A general contractor shall at all times have the welfare and safety of his workmen at heart. He shall comply, except as superseded by the state laws, with the provisions of the safety manual adopted by the Associated General Contractors of America, or the Safety Platform of the Construction League of the United States, or the rules set forth by the National Safety Council and local ordinances referring to safety measures, in so far as the same may apply to his class of work.

Section 5. Payment of Wages—A general contractor shall make payment of all wages as due in lawful currency of the United States, or its equivalent in the form of a bankable check. The contractor or his agents shall accept no rebates, directly or indirectly, on such wages, nor give anything of value or extend favors to any person for the purpose of influencing rates of wages or the working conditions of his employees.

Article V—Subcontractors

Section 1. Payments—A general contractor shall pay all subcontractors, material vendors and others not less than their proportionate amount of partial payments made by the owner to the general contractor during the progress of the work, and they shall receive final payment of the unpaid balance not later than ten days after the general contractor has received final payment from the owner, except where earlier payment and/or in greater amounts are mutually agreed upon.

Section 2. Prohibited Rebates, &c.—A general contractor shall not give or accept rebates, refunds, allowances, unearned discounts or special services to or from subcontractors, material vendors or others which are not extended under like terms and conditions to other purchasers of material or services of equal credit rating.

Section 3. Financing—A general contractor shall not permit subcontractors or material vendors on a specific contract to finance or guarantee his accounts.

Section 4. Bids Confidential—A general contractor shall not convey to any subcontractor or material vendor any substantial information prior to the award of the particular subcontract relating to the bid of any other subcontractor or material vendor who has made a bid to him or to any other general contractor, nor shall he mislead or deceive any subcontractor or material vendor as to the amounts and conditions of other bids for the purpose of obtaining a lower bid.

Section 5. General Requirements—A general contractor, in his relations with subcontractors, material vendors and others shall require such parties to adhere to the principles enunciated by this code of fair competition.

Section 6. Waiver of Legal Rights—A general contractor, in his contractual relations with other parties, shall not waive any rights affecting another party of interest without first fully informing such other party as to such action and receiving his consent in writing.

Section 7. Plans and Specifications—A general contractor shall not be held responsible or penalized for deficiencies in or omissions from the plans and/or specifications prepared by others and upon which the contract is based.

Article VI—General Contractors

Section 1. Qualification—A general contractor shall be properly qualified by capital, organization, experience and equipment to bid upon and properly execute the construction contract which he undertakes.

Section 2. Performance Records—A general contractor submitting a proposal for public works construction shall, as an essential precedent condition of qualification for public works construction, file his performance record with the Bureau of Contract Information, Washington, D. C., or any other agency authorized and designated by the Public Works Administrator provided by Title II of the act. Such records shall be available only to those entitled to information by reason of their responsibility for the award of contracts, the writing of contract bonds or the extension of credit. A general contractor shall keep such records current by submitting supplemental data at such periods as the agency shall prescribe.

Section 3. Credit Information—A general contractor shall make available upon request to those responsible for the award of construction contracts, pertinent information as to his current financial position, using the standard questionnaire forms developed and approved by and available through the Joint Conference on Construction Practices, Washington, D. C.

Section 4. Reports and Accounts—(a) A general contractor shall maintain a system of making reports and shall keep adequate accounts as provided in Title I, Section 3A, Paragraph 2 of the National Industrial Recovery Act. All moneys received and expenditures made shall clearly show the allocation, to each improvement of real property or a public improvement, of the funds received and disbursed on account thereof.

(b) Funds received by a general contractor for construction work shall be accepted and applied first for the purpose of paying proper costs of making such improvement, including amounts due to employees, material men, subcontractors and others. This shall not be construed to require a general contractor to keep in separate bank accounts or deposits the funds received under separate contracts, provided that books of account shall clearly show the allocation to each and every contract of the funds deposited in his general or special bank account or accounts.

Section 5. Contractual Agreements—The following bases of contractual agreements are recognized as fair trade practices, guaranteed price, cost of the work plus a fee, unit price, lump sum and other contractual methods not inimical to the public interest, providing that the regulations proposed by this code of fair competition are met.

Section 6. Submitting Bids—A general contractor, in submitting bids for the construction or improvement of either public or private works, shall be governed by the following regulations necessary to insure fair competition, since it is essential that whenever contracts are to be let by competitive bidding, terms of the competition shall be such as to insure parity of standing to all bidders:

(a) All bids shall be in writing signed by the bidder.

(b) A general contractor shall not take advantage in his bid of any special privileges, favors or understandings had with him by persons in control of the award. This, however, shall not prevent any such competitor, even though not the lowest bidder, from taking such contract, providing the award is made at his original competitive bid price, nor shall it prevent any contractor from accepting the award of such contract at any price where no competitive bids are taken.

(c) A general contractor shall not revise his bid after bids have been opened in order to improve his position with the owner, except he be the low bidder. Bona fide errors discovered after the opening of bids may be grounds for withdrawal of bid. He shall not encourage or induce the owner or his agent to reject bids and readvertise in order that he may revise his original offer, nor shall any general contractor bid upon a construction project upon which bids have previously been invited, received and opened at any time within ninety days from the date of the previous opening of bids next thereafter, except there be substantial changes of the plans and specifications.

(d) A general contractor shall not knowingly submit a bid nor accept a contract which does not include all direct and indirect costs and include a reasonable amount for profit and he shall maintain and keep on file his original estimates supporting his bid or contract.

(e) A general contractor shall not be required to accept the award of a contract after fifteen (15) days after the date of opening of bids.

(f) To establish parity in bidding as to wages, prior to establishment of wage rates according to Section 7 (b) of the act there should be established by competent authority rates on which all bidders shall base their bids (but not less than those set under Section 204 (c) of Title II of the act and set forth in Article IV, Section 2, herein) and which shall be effective under the contract until other rates have been established as provided by Section 7 (b) of the act, when they shall become effective, after which a proper adjustment of the contract price as to wages shall be made between the owner and contractor.

Section 7. Payments—A general contractor shall demand and insist upon receiving the contract payments as they become due in lawful money of the United States or its equivalent, as provided by the contract, and he shall not waive his right to receive any part of such contract payments, nor shall he return to the owner or his agent any part of such contract payments, nor shall he return to the owner or his agent any money or render him any service or give him anything of value not required by the contract.

Section 8. Unfair Practices—A general contractor shall not engage in the unfair practice known to the industry as "bid peddling" or any similar unfair practice. He shall not knowingly aid or engage in an unfair trade practice, whether or not specifically described in this code, and shall refuse to deal with any person or persons who have not complied with the code of fair competition herein defined.

Section 9. Surety—A pre-qualified general contractor, who has met the necessary qualifications entitling him to the work, but who is unable, due to conditions beyond his control, to obtain the proper surety required by the contract may agree with the owner and the National Industrial Control committee for general contractors upon a suretyship of some other nature.

Section 10. Disputes—A general contractor shall be ready and willing to settle disputed matters promptly. Where arbitration as a method of settling disputed matters is agreed upon, the rules of procedure as established by the American Arbitration Association shall govern, except as otherwise required by law. Payment shall not be withheld from the parties affected exceeding that sufficient to cover the amounts in dispute.

Article VII—Correlating Interests

To effectuate the purposes and the policy of the National Industrial Recovery Act and this code of fair competition for general contractors, it is essential and requisite that, in a construction work contract, all interested parties and participants, or their agents, be obligated to adhere and conform to the basic principles regulating it. Therefore, all such persons shall have correlative responsibility to adhere and conform to the basic principles of the National Industrial Recovery Act and this code of fair competition for general contractors.

Article VIII—Administration

Section 1, Amendments—(a) It is recognized, in accordance with Section 9, Paragraph B of Title 1 of the National Industrial Recovery Act, that the President of the United States may, from time to time, cancel or modify any rule or regulation in this code of fair competition prescribed for the general contracting industry.

(b) Amendments or revisions may be proposed by general contractors, acting through their national trade association designated as the Associated General Contractors of America.

(c) The provisions of this code may be further supplemented by groups of general contractors operating in the same class of construction work or in the same geographical region or locality, which supplements shall be proposed to the administrator of the National Industrial Recovery Act by the national trade association, when consistent with the basic code and other rules or regulations promulgated by the President, and the spirit and purpose of the National Industrial Recovery Act.

Section 2. Administration Committee—(a) to effectuate the purposes of the Code and provide for administrative control within the industry, there is established a "National Industrial Control Committee for General Contractors," which shall be the members and alternates of the Executive Committee which is appointed by and from the Board of Governors duly elected by the general contractors composing the national trade association, herein designated. That committee shall appoint five additional members representative of and responsible to non-members of the national trade association.

The National Industrial Control Committee for General Contractors shall have full authority to make all needful rules and regulations for the administration and enforcement of the provisions of this code, and, upon the complaint of a local or regional committee or interested parties, or upon its own initiative, shall make such inquiry and investigation and take such action as may be necessary under the operation of this code. This committee shall have full authority to establish subordinate State, local and regional committees and prescribe such duties, rules and regulations as are deemed necessary to carry out the purposes of this code and the National Industrial Recovery Act.

Section 3. Administration Expense—All general contractors as defined in this code shall bear their proportionate share of the expense incident to securing the approval of and administration of this code of fair competition under such rules and regulations as may be approved by the President under Section 10 (A) of Title I of the National Industrial Recovery Act.

Section 4. Effective Date—This code shall be effective when approved by the President of the United States and shall be applicable only to all construction work undertaken pursuant to contracts entered into or otherwise commenced after such approval date.

Letters to the Editor

Books by Frank B. Gilbreth

Sir—At the Newark College of Engineering a room, known as the Gilbreth Room, has been dedicated to the memory of the late Frank B. Gilbreth. This room now contains some of his papers, pictures and instruments, and a library of works on scientific management and human relations. We are anxious to acquire for this library copies of the following books written by Mr. Gilbreth that are now out of print: "Field System," "Concrete System," "Bricklaying System," "Motion Study Primer of Scientific Management," "Time Study, the Science of Obtaining Methods of Least Waste."

We would like to have you aid us in locating sources from which we may be able to acquire these books. If your readers have copies of any of these books or know where they may be obtained, we will be pleased to hear from them.

S. FISHMAN,
Newark College of Engineering.

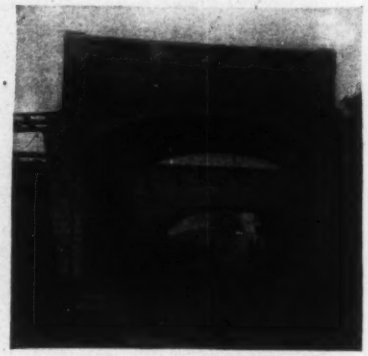
Newark, N. J.,
May 22, 1933.

Railway Builds Rigid-Frame Bridges in Ireland

Sir—With reference to your article 'Ten Years of Achievement with Rigid-Frame Bridges' in your issue of April 27, the accompanying table gives particulars of rigid-frame bridges that have been constructed by the London Midland & Scottish Railway Co. This type of bridge has been used on account of its inherent economy and the ease with which it lends itself to use on sites with restricted headroom and clearances.

The bridge at Carrickfergus is a rib design and is notable for its extreme skew. Generally speaking, I have found that a rib bridge is more suitable for over-bridges, while a solid barrel type is much more economical for under-bridges, especially as it requires a mini-

Rigid-frame bridges in Ireland. View at top shows two of three structures (third was built over tracks in foreground this year) which carry standard railway loads.



RIGID-FRAME BRIDGES DESIGNED AND BUILT BY LONDON MIDLAND & SCOTTISH RAILWAY CO

Location in Northern Ireland	Use	Material	No. of Bridges	No. of Spans	Span Lengths, Ft.	Date Built
Carrickfergus	Over Railway	Concrete	1	1	70	1929
Whitehead	Under Railway	Concrete	1	1	13	1929
Whiteabbey	Under Railway	Concrete	3	1	27	1931, 32, 33
Monkstown	Over Railway	Concrete	2	1	58	1932
Jordanstown	Over Railway	Concrete	1	3	23-34-23	1931

mum depth at the center. The relative costs of both designs under conditions ruling here at present are about equal. The under-bridges are of very slender section and have been designed to carry British standard railway loads.

H. P. STEWART,
London, Midland & Scottish Railway Co.
Belfast, Ireland.
May 11, 1933.

Large Hoist Drums

Sir—In the May 18 issue, p. 668, there is an illustration of a hoist drum for the cableway at Hoover Dam, and the statement is made that this is the largest drum ever built.

I wish to call your attention to the fact that we have built many hoist drums much larger than this. Almost 30 years ago we built drums 25 ft. in diameter, winding more than a mile of rope of larger size than 1¼ in., as mentioned for the drum shown in your publication.

A hoist built by us for a mine at Hancock, Mich., has a drum 30 ft. in diameter, the drum alone weighing 516,000 lb. and winding 13,300 ft. of 1⅜-in. rope.

At the present time we are building two hoists, each of which will have two drums that will weigh 225,000 lb. apiece and will wind more than a mile of 1½-in. rope. The size of drum that you show in the illustration is "just another hoist drum" in our plant. No doubt the drum shown is the largest for that particular service, but there are a number of mine hoists operating with much larger drums than this.

DELBERT KAY,
Advertising Manager,
Nordberg Manufacturing Co.
Milwaukee, Wis.,
May 20, 1933.

Early Rigid-Frame Bridge

Sir—In connection with your recent article "Ten Years of Achievement with Rigid-Frame Bridges" it should be of interest to note that two "rigid-frame" bridges were built by the city of Fergus Falls, Minn., in 1919-'20 similar in type and antedating those of the Westchester County Park Commission. They are of ribbed construction with 90-ft. clear spans and were designed as two hinged arches in the same manner as the Westchester County bridges. This form was adopted because of the necessity of providing for later dredging and changes in the river channel. The bridges were designed in 1919 by the writer for A. C. Eschweiler, architect.

The writer also wishes to take this opportunity of calling attention to the inconsistency of applying the term "rigid frame" to bridges that are designed as elastic frames.

CHARLES S. WHITNEY,
Consulting Engineer.
Milwaukee, Wis.,
May 10, 1933.

One of the first rigid-frame bridges built in America is located at Fergus Falls, Minn.

Proportioning Concrete

Sir—W. W. Zass's article, "New Method of Proportioning Concrete for Roadwork," (*ENR*, Sept. 1, 1932, p. 247), presents information on which I would like to comment.

Mr. Zass treats of the relationship between the new method and three well-known calculation methods—i.e., fineness modulus, surface area and mortar void. It is not my intention to attempt to discuss this relationship, but rather to confine my comments on the effect of size and grading of coarse aggregate to the amount of fine aggregate required to make a well-balanced mix.

The gist of the entire article may be summed up in two statements made by the author in which he said that, "Unity minus the solid volume of the coarse aggregate per unit volume of coarse aggregate equals the percentage by solid volume of fine aggregate to be used in the mix," and "The relationship maintains for aggregate of any sizing, either of the poorly or better-graded types, with the exception of fine aggregate, of which more than 5 per cent retained on the No. 4 sieve may require that such excess be equated as coarse aggregate."

Under certain given conditions the above statements will hold, but it has been the writer's experience that coarse aggregate of small maximum size, or larger gravel containing a high percentage of middle, of intermediate or of the small size will require more mortar, and therefore a higher percentage of fine aggregate, than would be indicated by the percentage of voids in the compacted gravel. This condition, I believe, is due to the large surface area of the finer aggregates. There is no question but that working on an absolute volume basis is an ideal approach to designing concrete mixtures, although this fact has not been generally appreciated in the past. In the early '90's, René Feret, eminent French engineer, first employed absolute volume as the basic measure of ingredients, including water, and developed the most fundamental law of concrete mixtures: "The volume of concrete produced by a mixture of aggregates, cement and water is equal to the sum of the absolute volumes of the aggregates, cement, water and entrapped air."

Messrs. Talbot, Richart and Gonnermen, 1921-'24, also used absolute volumes as the basic measure of proportions in their paper, "The Strength of Concrete, Its Relation to the Cement, Aggregate and Water," Bulletin 137, Engineering Experiment Station, University of Illinois.

The author determined that the absolute volume of a 2-in. gravel was 0.649 and that the percentage of voids was 35.1. In this case 35.1 per cent fine aggregate to total aggregate would prove to be the optimum percentage, as indicated by tests conducted at U. S. Lock and Dam, Marmet, W. Va. If the above-mentioned gravel were poorly graded, however, and contained an excessively high percentage of the smaller or the intermediate sizes, the mixture would be harsh, making it necessary to add 1 per cent or more of fine aggregate and cutting down the coarse aggregate by a like amount, the magnitude of the change depending on how poorly the gravel were graded. If a small gravel, say ½-in. maximum size, were used, it would be necessary to use fine aggregate in excess of the percentage of voids in coarse aggregate because of the greater surface area of the coarse aggregate to be covered with mortar. Tests made at Marmet show that, for two classes of coarse aggregate (Ohio River sand and gravel was used), of 2-in. and ½-in. maximum size, both having an absolute volume per cubic foot of 0.695 and consequently a void percentage of 30.5, the ratio of sand to total aggregate for the 2-in. material was 30.5 per cent, but for the ½-in. material it was necessary to use from 34 to 35 per cent sand to total aggregate in order to obtain a workable mixture. This increase may be readily understood when it is remembered that the surface area of the ½-in. is considerably greater than for the 2-in. gravel. The optimum percentage of the fine to total aggregate for the ½-in. material was determined by a mechanical method somewhat similar to Fuller's maximum density method.

It is the writer's opinion that any calculation method of designing concrete mixtures is very limited and should be applied only to determine the approximate percentage of fine to total aggregate, to be followed by mechanical tests to determine the optimum percentages. This applies particularly to the fineness modulus and surface-area methods, which are based on ideally graded aggregate, spherical in shape.

JOHN C. SPRAGUE,
Inspector, U. S. Engineer Office.
Marmet, W. Va.,
May 26, 1933.

Engineering News-Record

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The Contracting Code

CREDITABLE PROMPTNESS has been exercised by the contracting business in settling upon and submitting a code of fair competition in accordance with the requirements of the National Industrial Recovery Act. As drafted and published in this issue, the document may be classified as a master code to be supplemented by detail codes applying to particular elements of the contracting business. With an industry composed of so many diverse elements as construction, no other plan was logical. It permits the quick establishment of general code principles and policies that will allow construction to go ahead and labor to have employment while supplemental special rules are being developed and fitted into the basic document. In its general tone the proposd code sounds a note of fair dealing and reflects a disposition to correct abuses that have grown to alarming proportions in contracting practice. Some of the details, such as the provision respecting wages, may reasonably be held to call for more specific definition, but in general the code provides for most of the constructive reforms that have been needed in contractual relations. It can be looked upon as providing an unusual opportunity for industry improvement rather than as a restrictive measure that can only be accepted grudgingly.

An Engineers' Code

THE contractors' code can hardly be made fully effective, however, unless the engineers and architects under whom they work also adhere to the principles of fair dealing upon which it is based. As was pointed out in these pages last week, the architect and engineer stand in a key position to prevent bid shopping and bid chiseling. Further, so long as they continue to countenance questionable competitive methods, bid shopping and other practices in their own dealings, there is little prospect that the rest of the construction industry can be raised to a higher plane. The Recovery Act, therefore, presents a challenge to both professions to get rid of practices that they have been unable previously to slough off. The purposes of the act are threefold: to end unfair competitive prices, to raise wages and to increase employment through shorter hours of work. Neither profession is free from unfair practices, both are notorious for the poor wages and the long hours of their junior employees. Some may argue that architects and engineers do not come under the provisions of the Recovery Act, that theirs is a profession and not an industry. The contention may be granted, but the fact remains that these professions are but a part of the whole construction industry; and if it can be shown that their practices adversely affect other elements of that industry, or that the wages they pay and the hours they work their men are out of line with wages and hours of other elements of the industry, means probably will be found to enlist them under the provisions of the Act. An engineers' code, therefore, is not an improbable development, and some careful thought must be focused on the question in the very near future.

Steel Sets an Example

THE CODE for the steel-manufacturing industry was submitted to the National Recovery Administration on July 15. On July 17 a dozen or more of the large steel producers voluntarily granted a 15 per cent wage increase, without waiting for the code to become effective. Such prompt compliance with the spirit and intent of the Administration's recovery program is gratifying and commendable. The remarkable increase in industrial activity coupled with recent attempts on the part of some industries to raise prices ahead of wages has recently tended to create an unhealthy situation in which real wages, as measured by purchasing power, actually would decrease. The steel industry's wage rise is reassuring as demonstrating that this key industry appreciates and subscribes to the cardinal principle behind the recovery program—namely, increased purchasing power. Similar voluntary wage increases on the part of other industries would be helpful in the period between now and the time that the various codes can be put into effect.

Gas-Tax Diversion in Court

DIVERSION of gasoline taxes to other uses than road construction is receiving quite different decisions when submitted to popular vote and to the courts than have generally been handed down by legislatures desperate for relief funds. In California, as noted last week, a popular referendum very definitely turned down a proposal for transferring $17,000,000 from the highway-improvement fund to the general state fund. Just recently the Circuit Court in Sangamon County, Illinois, has granted an injunction forbidding state officers to pay out highway funds for purposes other than road improvement. Of the two decisions, that of the court is of more significance, as it is based on impairment of the obligation of contract. Apparently the constantly increasing imposts accepted by motorists as a charge for improving highway service may mean to the courts payment for road service and not a donation for any public purpose that an inventive legislature can devise. The question should be put up definitely for answer in other states and by higher courts. It is presumable that surprising reversals might be the outcome of a battle that so far has generally been against those who have been fighting to keep road taxes for roads.

An Old Lesson

NO HAZARD of estimating is a more serious threat to accuracy than the appraisal of underground rock conditions. Any engineer whose observation extends back a generation can call to mind major occasions when all engineering judgment was rendered useless by the ability of mother earth to keep her secrets of rock and soil from the keenest eyes of science. The slides that have added millions of yards to the estimated volume of the great Culebra Cut at Panama are yet a continuing

menace to engineering ability to write *finis* to the construction of this ocean-to-ocean waterway. Again the two miles of unexpected squeezing rock at Moffat Tunnel trebled costs that had been laid down as reliable by the best judgment of nation-famous tunnel engineers and contractors. So in the case of Prettyboy Dam, described in this issue, the doubling of excavation and concrete volume, owing to original misjudgment of rock conditions, is another example of the limited vision that the engineer can apply to what lies beneath the very few feet of surface that his instruments of exploration can search with certainty. The lesson to be drawn is an ancient one—merely the warning that nothing underground can be taken for granted on the evidence of surface appearances. All the devices possessed for testing subterranean rock, where its character affects the safety of costly engineering works, have always to be called into service. This is particularly true of structures for impounding water whose failure carries such potential danger to life and property.

Trend Toward Theory

DESIGN THINKING in the field of structures has long followed a definitely "practical" trend, and quite properly so in view of the ease with which quantitative theorizing on structural action goes over into super-refinement or even error. But the place of theoretical study nevertheless is not undervalued by responsible workers in the structural field, as is proved by many facts of recent years, among them the strong interest in research and the steady rise of continuous, rigid frame and other hyperstatic types of construction. The additional emphasis given to theory by the programs of the structural sessions at the Chicago meeting of the American Society of Civil Engineers is therefore particularly interesting. It clearly reflects a new trend toward more thorough prosecution of theoretical analysis, from which much may be expected in fuller development of structural science and skill. The practical aspects of structures also take on new importance in this change, for they remain the essential guides by which theory must be kept in contact with the factors on which performance finally depends—service conditions and properties of the materials used. Both of these factors will always elude precise quantitative expression in sufficient degree to make dogmatic utilization of theory hazardous. Provided it is securely controlled by practical perception, however, theoretical investigation will carry the structural art forward to new heights of accomplishment.

A Great Research Laboratory

THIS ISSUE brings to completion the group of three articles outlining the work of the U.S. Waterways Experiment Station, which form a primary part of the series of studies being published on the new plans for the Mississippi River. In so brief a review there is no possibility of presenting more than a tithe of the constructive experimental truths that have been developed in a program that has only touched the skirts of opportunity. The new laboratory is a tool for the determination of river and harbor hydraulic phenomena that places American engineers in position to lead the world in model research. With the greatest natural waterways of the world in course of development, the potentialities for profitable use of these research results are unlimited.

Turning to its specific records, the laboratory has defined new principles of current action, detritus movement, sediment transportation and bed erosion, has set forth the limits of working plans for specific control structures as in many cases of spur-dike regulation of low-water channels, and has verified the accuracy of the plans for completed emergency structures for flood control, such as the Bonnet Carré and New Madrid floodways. These accomplishments are brought into clear vision in the articles on methods and results of model experiments. They alone have justified the cost of the laboratory and its operations.

Engineers everywhere should make themselves acquainted with this new instrument for hydraulic research. In combination with the new laboratory of the Bureau of Standards, built for quite different lines of study, it places facilities for hydraulic experimentation on a parity with those provided by the great chemical, mechanical and electrical research institutions upon which American engineering and industry have drawn for technical guidance.

Profit in Contracting

CONTRACTING as a business and not as an art of construction will be discussed in a series of ten articles beginning in this issue. Appropriately, this first article considers profit. Business is for profit, and contracting is primarily business. This fact is too often missed in our consideration of contractors' work. The visible evidence of the great forces and huge units of fabrication blinds us to the fact that behind these activities are problems of selling and buying and of appraisal of business values whose successful solution precedes the spectacle of preparing the emplacement and erecting the structure.

Profit, as considered in the study of the problems of contracting, conveys a more fundamental thought than that involved in common trade of transferring ownership for an increase in price. Its meaning goes deeper than mere delivery of service. It is a premium justified by exceptional service, and it has no justification unless such service is given. Ordinary service warrants adequate wages, but not the reward of profit in addition. These are truths that are not perceived in much of the current discussion on the profits of contracting.

This service, as the article points out, extends beyond the point of giving the buyer a better product at a market price, to wise exercise of judgment of business cycles and price levels as they influence profit. It extends to the obligation of providing working capital and business organization that will glean all the means of profit that shrewd management and prompt financing make realizeable. In a competitive market these increased earnings pass on to the owner in some measure, in lower bid prices, more careful construction and more agreeable business relations.

Complete discussion of so broad a subject as profit in contracting is impossible in the narrow limits of a single article. The most that is possible is to imply controlling influences and open up vistas for constructive thinking. This is done in the article on profit in this issue, and it will be continued in the discussions of securing business, purchasing, surety bonding and other contracting-business problems that will be considered in later articles.

NEWS OF THE WEEK

Ten Zones Set Up For Administration Of Public Works

THE Cabinet Advisory Board on Public Works on July 13 divided the country into ten regional zones for administration purposes. Secretary Ickes, Administrator, said that he had been empowered to select the cities from which the work will be directed, and expected to announce them soon. The ten regions selected were as follows:

1. New England.
2. New York, Pennsylvania and New Jersey.
3. Wisconsin, Illinois, Michigan, Indiana and Ohio.
4. North Dakota, South Dakota, Nebraska, Minnesota, Iowa and Wyoming.
5. Montana, Idaho, Washington and Oregon.
6. California, Nevada, Utah and Arizona.
7. Texas, New Mexico and Louisiana.
8. Colorado, Kansas, Oklahoma, Missouri and Arkansas.
9. Mississippi, Alabama, Georgia, South Carolina and Florida.
10. Tennessee, Kentucky, West Virginia, Maryland, Delaware, Virginia and North Carolina.

President Roosevelt has announced that the full Congressional authorization of $3,300,000,000 for Public Works will be expended.

Of the $66,000,000 of Federal Projects approved by the Board on July 12th, a total of $64,561,542 has been given the sanction of the President. This sum includes a $38,000,000 allotment for Boulder Dam. This Federal allotment will be expended through thirty-five governmental agencies. The Department of the Interior received $53,420,319, by far the largest amount going to the Reclamation Services. Twelve agencies of the Department of Agriculture were allowed $2,060,154. Five agencies of the Department of Commerce were allowed $6,076,551. The Department of Labor got $1,344,480 for immigration work. The State Department received $1,528,000 for construction work under its supervision. The sum of $102,438 was allowed the Treasury Department for Public Health Service. The Independent Offices were allowed $400,000 of which $200,000 was for the Arlington Memorial Bridge work in Washington, and $200,000 for aviation experimental work. This will be carried on by the National Advisory Committee for Aeronautics.

The Public Works Administration estimates that over 278,200 man-months of work will be provided by the allotments.

The Board also allotted $50,000,000 for roads in national forests, parks and Indian reservations, as required by law. The sum of $4,000,000 has already been allocated to the states for highway construction, and $238,000 has been allotted to the Navy for building ships.

In addition, the Public Works Administration on July 14th approved "in principle" advances to twenty-five municipal projects for waterworks and sewerage systems, the cost of which will total $952,068. Public Works Administrator Ickes has announced that this approval was tentative, subject to satisfactory agreement by the municipalities with the Public Works Administration on legal and financial details and the establishment to the Administrator's satisfaction that the municipalities were bringing their expenditures within prudently estimated revenues and would be able to repay loans. The projects are as follows:

Arab, Marshall County, Ala.—Waterworks System	$ 23,000
Uniontown, Ala.—Waterworks improvement	6,000
Sylacauga, Ala.—Waterworks system	100,000
Montgomery, Ala.—Waterworks system	70,000
Pahokee, Fla.—Waterworks system	100,000
Warrenton, Ga.—Waterworks	6,000
Petersburg, Ind.—Waterworks improvement	50,000
Beech Grove, Ind.—Sewers	37,000
Salyersville, Ky.—Waterworks system	42,000
Northport, Mich.—Waterworks	33,000
Clarkton, Mo.—Waterworks system	20,000
Fort Benton, Mont.—Waterworks	45,000
East Brunswick Township, N. J.—Water system	60,000
Pleasantville, N. J.—Extension sewer system	27,000
Proctorville, Ohio—Waterworks and sewer system	58,000
Belle Fourche, S. D.—Improvement waterworks	30,000
Spearfish, S. D.—Improvement waterworks	41,000
Kamas, Utah—Waterworks	12,500
Tooele City, Utah—Waterworks	50,000
Orangeville City, Utah—Waterworks	9,000
Spanish Fork, Utah—Waterworks	80,000
Sandy City, Utah—Waterworks	14,000
Poulsbo, Wash.—Sewer system	18,568
Newcastle, Wyo.—Waterworks	20,000
Total	$952,068

These projects have been before the R.F.C. and have been thoroughly examined there. The R.F.C. had been unable to make loans because of restrictions in the R.F.C. Act, which do not exist in the Public Works Act.

Road Fund Distribution By Ten States Approved

Approval of the Federal Public Works Administration has been given to the distribution made by ten states and the District of Columbia of the public works funds alloted to them for highway construction. A total of $75,643,445 is represented, out of the $400,000,000 assigned under the Public Works Act for that purpose.

The states whose fund distribution were approved are Indiana, Kentucky, Oklahoma, Oregon, South Carolina, Vermont, Virginia, Washington, District of Columbia, Missouri, and Wisconsin.

In addition, New York and Utah secured the tentative approval of the program maps submitted for the work to be done. This enables the construction in those States to start in the immediate future.

Columbus Officials Called To Explain Sewage Plant Delay

Mayor Worley, of Columbus, Ohio, city treasurer D. S. Creamer, and members of the city council have been notified to appear before the Ohio Supreme Court on August 20 to prove that the city is taking suitable steps to end the sewage pollution of the Scioto River, or to show cause why no action has been taken.

The Supreme Court has granted an alternative writ of mandamus sought by the attorney-general at the reuest of Dr. H. G. Southard, state director of health. The city has been under order of the state health department to build a sewage disposal plant to clean up the Scioto River. Following the rejection of a bond issue by the voters of Columbus in November, 1932, the city has sought unsuccessfully, to provide a sewage treatment plant in accordance with the state's orders. (See *ENR* March 23, 1933, p. 389 and May 18, 1933, p. 666).

Public Works to Go Ahead—Roosevelt Program Not a Grab Bag—Ickes

(Washington Correspondence)

PRESIDENT ROOSEVELT'S announcement that his purpose is to spend the full $3.3 billions authorized by Congress is regarded as definitely repudiating the proposal of Lewis Douglas, Director of the Budget, to curtail the public works program. But the question whether the total is ultimately to be spent is not nearly so important now as the speed with which the program is initiated. On this the President seems to be entirely in accord with the deliberate policy of both Mr. Douglas and Secretary Ickes, Administrator of Public Works. It is epitomized in Secretary Ickes' emphatic statement that "this is not a grab bag. We want to be sure that the money is wisely spent." The same yardstick will be applied to both federal and non-federal projects.

Although the advertised total for public works is $3.3 billions, of the amount appropriated by the National Recovery Act, close to $1.3 billions is allotted by the statute or otherwise ear-marked, leaving $2 billions to be allotted for public works as the President and the Public Works Board may see fit.

The general plan for carrying forward the program contemplates, in broad outline, the expenditure of $500 millions to $600 millions on big flood control, navigation and other river and harbor projects such as the 9-ft. channel on the upper Mississippi. This leaves about $1.4 billions for a wide variety of smaller federal, state, county, municipal, housing and private projects.

Very few new post-office or other federal buildings will be included, as a study of such proposals has convinced the President that in reckoning the cost over a period of years, it is cheaper for the government to rent than to buy in most cases. The Treasury Department's building program has been referred to the Budget Bureau with a request from the Public Works Board that it send back a list of only such projects as will reduce the government's housing expense in the future. The Treasury's original "preferred" list included 948 buildings, totaling $170,000,000.

Army program reconsidered

The War Department's housing program of $135,000,000 and its plans for mechanization and motorization of Army units have been withdrawn by Secretary Dern, evidently for trimming, as Secretary Ickes remarked that the department had included "everything it could think of in its estimates."

Following a conference with President Roosevelt last Sunday, Secretary Ickes announced that the Army's program of flood control and other river and harbor works would be reconsidered by the Public Works Board. He explained that the objective is not necessarily to curtail, in this instance, but to select such projects as will further a coordinated program of development. Referring particularly to the Mississippi Valley, Secretary Ickes said that a complete study will be made for the purpose of undertaking work that will contribute to the ultimate plan for the valley.

Grants up to 30 per cent of the cost of labor and materials on state, county and municipal work will be made as contemplated by the law but beyond that all projects will be scrutinized with a view to returning to the U. S. Treasury such money as may be advanced to finance projects. Assuming that non-federal work reaches a total of $1.4 billions, about $1 billion must be repaid.

Housing program contemplated

Preferential consideration will be given to projects aptly described as "regenerative." The thought is that money spent for public improvements will attract both population and private capital to such areas, and thus set up a train of private expenditures. The engineering staff of the Public Works Administration hopes by this broad program of coordinated federal, state, county and municipal work to spread broadcast better engineering methods, as well as to stimulate economic and social planning.

Housing will be seriously considered, according to Secretary Ickes, but he said that the board will "let ride for awhile" the question of interest rate on loans for housing and private projects "as there probably won't be much of that anyhow."

To the extent that housing may figure in the program, the board's idea is to set up examples in various parts of the country. E. J. Bohn, chairman of Cleveland's housing committee, has proposed that $25 millions be ear-marked for Cleveland. He has informed Secretary Ickes that several housing projects will be filed shortly. Bohn has discussed with MacKay Smith, R.F.C. legal counsel on housing, a proposal to frame state legislation that would make housing corporations eligible for 30 per cent grants from the federal fund. It is understood that the Public Works Administration prefers a piecemeal method of slum clearance and construction in order to avoid the creation of new fester points. Projects in which land speculation rather than housing is discovered to be the motive will be weeded out. The board will insist upon low rentals.

Cities whose budgets have been hard hit by tax delinquencies and unemployment relief are worried by the strict policy adopted by the board with reference to financing. Secretary Ickes' only comment on this situation to date has been that all applications will be considered on their merits. It is anticipated that, in such instances, the board may elect to use the statutory provision authorizing the federal government to erect and lease the proposed improvements.

President Roosevelt announced on July 14 that proposals by municipalities to build light and power plants "will be very favorably considered, provided of course, that they are self-liquidating."

Hand labor to be curtailed

The Public Works Board does not share the anxiety of contractors concerning the price situation and is opposed to fee contracts. Preference for hand labor will not be carried beyond the point where it ceases to be economical. To do so, the board believes, not only would thrust a burden on the community in the future when the obligation to the federal government must be liquidated but might prevent another community from participating in the public works program if funds are exhausted by high-cost methods of construction.

The organization of the Public Works Administration will be decentralized in name only. The state committees will send project proposals direct to Washington. Approval by the regional administrator, or "advisor" as he is now called, will not be a prerequisite as first contemplated. The regional advisor's job, as explained by Secretary Ickes, is to keep the state committees actively at work bringing projects forward. The state governments will be expected to furnish clerical help and assume the expenses of the state committees.

A break-down of the $3.3 billion appropriation according to the allotments made by the law, or otherwise earmarked, and the distribution of funds approved to July 18 by the Public Works Board follows:

$ 400,000,000	to the States for road-building.
238,000,000	for the "treaty-strength" naval building program.
100,000,000	for the Agricultural Adjustment Administration and Agricultural Credit Administration.
50,000,000	for highways, roads and trails in national forests, parks and Indian reservations.
25,000,000	for subsistence homesteads.
$ 813,000,000	total allotted by law.
500,000,000	tentatively earmarked for the Tennessee Valley Authority, Conservation Camp Corps, Army Mechanization and motorization, and other purposes.
$ 64,561,542	Alloted by Public Works Administration for federal public works projects to be expended through 35 government departments and agencies.
952,068	for 25 municipal waterworks or sewage projects carried over from the R.F.C.
$1,378,513,610	
1,921,486,390	balance remaining for allotment to federal and non-federal public works.

San Francisco Bay Bridge Start Marked by Ceremony

A golden spade turning up the first earth to be excavated and a remote-control blast touched off by President Roosevelt marked the beginning of construction on the San Francisco-Oakland Bridge on July 9. The ceremonies, held on Yerba Buena Island where the two parts of the bridge will be joined by a tunnel, featured the presence of governors of California and Nevada, past-president Hoover and many notables of the San Francisco region. Mr. Hoover spoke of this project as "the greatest bridge yet erected by the human race" and C. H. Purcell, chief engineer of the project and of the state highway commission said he hoped to see traffic over the new structure in January, 1937.

St. Paul and Minneapolis Declared a Sanitary District

The Minnesota Department of Health, on July 5, served notice on the governing bodies of the Cities of St. Paul and Minneapolis, that the discharge of sewage and industrial waste in the Mississippi River endangered public health and creates a public nuisance, and that the areas comprising the two cities are declared to be a sanitary district. This notice is in accord with the provisions of the law creating such districts passed by the last session of the legislature. (See *ENR* April 27, 1933, p. 542.) The act applies only to St. Paul and Minneapolis.

Steel Industry Submits Its Code

The steel industry, comprising those companies producing and selling pig iron, iron and steel ingots and rolled or drawn iron or steel products, submitted its code of fair competition to the National Recovery Administration on July 15. Because of the magnitude and basic nature of the steel industry, this is one of the most important codes that will be drafted. In addition, it outlines significant new operating and selling practices for the industry. Interest will also be focused on the hearing before the National Recovery Administration when it is expected that a drive against the steel makers' open shop practices on the part of union labor will take place. The code will be administered by the directors of the existing Iron and Steel Institute. It is claimed that 90 per cent of the capacity of the industry is represented by those companies subscribing to the code as it is now drawn.

Regarding working conditions, the code sets up an average 40-hour week and states that employment will be distributed as widely as possible among all employees normally attached to the industry. A 15 per cent wage increase is provided for, and piece-workers' wages are to be readjusted to conform to this increase. Minimum rates of pay for unskilled workers vary from 40 cents an hour in such districts as Pittsburgh, Youngstown and Chicago down to 25 cents in the Southern districts. In most of the 21 designated districts the rates are from 35 to 38 cents. Employees are given the right to organize and bargain collectively and are not to be compelled to join company unions. The

code also states that the plants of the industry are open to capable workmen without regard to their membership or non-membership in any labor organization. (Schedule C of the code sets forth in full the fundamental principles of employee representation plans that have been in effect in the industry for a number of years. The code states specifically that these principles should be maintained.)

The code makes no provision for controlling or regulating the volume of production, stating the belief that the elimination of unfair practices, which are outlined, will automatically control over-production and inequalities in distribution and sales. The code stipulates that no new blast furnaces, open hearths or Bessemer converters shall be built, unless an amendment is passed permitting it.

Schedule I of the code lists unfair practices, included among which are the granting of bribes, gratuities, or gifts, cancellation of a sale except for a fair consideration, giving rebates, rendering any service to a purchaser unless fair compensation is paid, shipping on consignment, guaranteeing purchasers against price declines and in general making terms to purchasers more favorable than the terms provided in the code's schedule. A penalty of $10 a ton on any product sold in violation of the code is prescribed.

Members are required to file with the Institute's secretary a list of base prices of all of their products, and the code gives the directors power to fix fair base prices if this is necessary. The code establishes basing points for all steel products. Delivered prices shall not be less than the sum of the published base price and the all-rail published tariff freight charges from the basing point to the place of delivery. Base prices cannot be changed without filing a new list of base prices with the secretary.

Delaware and Raritan Canal Offered to New Jersey

The historic Delaware and Raritan Canal, extending forty-four miles from Bordentown to New Brunswick, New Jersey, has been offered as a gift to the State of New Jersey. The canal was started in 1830 and completed in 1834. In 1871 it was leased by the Pennsylvania Railroad, together with the lines and property of the United New Jersey Railroad and Coal Company, by which the road obtained direct access to New York.

The offer of the canal to the state is conditioned by the provision that the railroad shall retain the right to cross and recross the canal and to use any of the property not required for canal purposes, the state to agree that otherwise the property will not be used for railroad purposes, and that the state will relieve the company of all obligations under the lease of 1871.

A special committee created by the legislature this year to study the feasibility of the state's acquiring the canal is expected to meet within the next few weeks to consider the offer.

The canal was not open to navigation this year, the company contending that it lately had shown a heavy annual loss. Litigation testing the right of the railroad to abandon operation of the stream without the consent of the Public Utility Commission is now pending in the federal court.

Cement Industry To Put in Force Wage and Hour Provisions

The minimum-wage and maximum-hour provisions of the code of fair competition to be submitted by the cement industry is being put into effect at once, according to an announcement by the Cement Institute.

According to a letter from Charles F. Conn, President of the Cement Institute, to the National Recovery Administration, the industry has been finding such difficulties in writing its code that considerable delay in submitting it was being experienced. Sensing the need for prompt increase in purchasing power in the country, the industry has decided that the new wage and hour provisions will be put into effect generally as soon as possible, but not later than August 1.

There is to be a minimum wage of 40c. per hour, with appropriate increases for wage earners in the higher classes, and a maximum time of employment of 36 hours per week. A minimum wage is to be subject to adjustments due to variations of conditions geographically. The time of 36 hours is to be the average over a six months' period, with permission to work a maximum of 42 hours in any given week.

The Cement Institute represents 91 per cent of the cement plants of the country and 97 per cent of the production capacity.

Contractors' Code Characterized as a Basic Code

THE code of fair competition and working conditions submitted by the general contractors to the National Recovery Administration on July 11, and published in full on p. 82 of this issue, rates as a basic or master code for construction. According to A. G. Tozzer, executive vice-president, Turner Construction Co., and chairman of the committee that negotiated and presented the code, it is planned, once the basic code is accepted, to draw up supplemental codes for the four principal divisions of contracting—highways, buildings, railroad construction and public works.

In fashioning the present basic code, every effort was made to make it truly representative. The initiative in the work was taken by the Associated General Contractors because of its established national organization, but every effort was made to secure the cooperation of non-members. Thus the early drafts of a code, which were completed about a week after the National Industrial Recovery Act was passed, were mailed broadcast. Something

EARTH-DAM CORE WALL NEARS COMPLETION AT SPRINGFIELD, ILLINOIS

Work on the Lake Springfield water-supply project at Springfield, Illinois, is being pushed ahead rapidly. The concrete core wall is nearing completion, excavation is under way for the spillway, and earth embankment is being placed wherever possible. The two long highway bridges that will span the lake are also well along toward completion.

The dam will be 1800 ft. long, 30 to 35 ft. high, and of rolled-earth type. It will impound the water of Sugar Creek, a tributary of the Sangamon River above Springfield, creating a lake covering 4300 acres and impounding 21 billion gallons of water. The 35-mile shoreline will be developed for recreation purposes.

The cost of the project, $2,500,000, has been financed by a bond issue voted in 1931. It is expected, according to Charles H. Spaulding, superintendent of water purification, that the entire cost of the project will be carried by the city water department without any increase in rates.

The project has been invaluable in providing unemployment relief. During the past two winters 200 men found employment on the lake area, clearing land to be submerged. At the present time 225 men are employed in constructing the dam and the two principal bridges. In addition, 100 relief workers are given employment on two miles of 30-in. water main being laid into the city; and 30 men are employed riprapping various embankments. Practically all the labor is recruited from among residents of Springfield. The last addition to the labor force consisted of 400 members of the C.C.C. (reforestation army) provided by the Federal Government to quarry and place riprap along the shore. Burns & McDonnell Engineering Co., Kansas City, Missouri, are the consulting engineers. S. T. Anderson is in charge of lake construction for the city. C. E. Carson Co., Chicago, is the general contractor with H. H. Enbody & Son, Aurora, Ill., placing the earth embankment.

over 1,000 suggestions for revisions were received. The next step was to call an open meeting of all general contractors in Chicago on June 26 at which the revised draft was discussed further. At this meeting it was said that representatives of some 2,200 non-members of the A.G.C. were present. This meeting appointed a committee composed of members and non-members of the A.G.C. to draft a code for general contractors. Finally, the draft so prepared was given a final examination and revision by a meeting in Washington on July 10 to which all elements of the construction industry were invited, including architects, engineers, materials producers and vendors, and subcontractors.

The proposed code provides for a 150-hour month as compared with an estimated present average of 206 hours per month. Until minimum rates of wages are established, regionally or locally, by mutual agreements between employers and employees, it is contemplated that the rates established by the various state highway departments in conformity with Title II of the Act can be used. At present these rates average 35⅞ cents per hour in 36 states that have a state-wide minimum for unskilled labor. Rates in other states vary from 29 to 41 cents per hour.

A National Industrial Control Committee for General Contractors is established by the code as the administrative body. The committee that negotiated the code was made up of Mr. Tozzer; W. A. Bechtel, San Francisco; A. P. Greensfelder, St. Louis; Richard Hopkins, Albany; A. E. Horst, Philadelphia; Henry J. Kaiser, Oakland, Calif.; James B. Kenny, Denver; B. L. Knowles, Worcester, Mass.; G. S. Lambie, Amarillo, Tex.; W. G. Luce, New York; W. J. Lynch, Chicago; A. J. McKenzie, San Antonio; Charles H. Simpson, Nashville; William Steele 3d, Philadelphia; Joseph A. Tomasello, Boston; George B. Walbridge, Detroit; and David J. White, Boston.

No date has yet been set for the hearing on the contractors' code. If it follows theoretical lines, the hearing will be conducted by the deputy administrator in charge of the capital goods industries, who is Malcolm Muir, president, McGraw-Hill Publishing Co. Some of the contractor officials on the above-named committee are in Washington this week, making arrangements for the hearing.

Road Atlas of United States Being Prepared in Washington

A new road atlas covering the entire United States is being prepared by the Bureau of Public Roads and the Geological Survey for the use of the Public Works Board. The individual states and a strip immediately surrounding each will be blocked off in rectangles, 90 by 130 miles, on a scale of 8 miles to the inch. On these sheets, obtained by photographing the Survey's base maps, which are on a scale of 4 miles to the inch, the Bureau of Public Roads will trace the projects planned by the states under their allotments of the $400,000,000 grant by Congress.

The maps were requested by the Public Works Board, as none of the state road programs will be finally approved until the board is satisfied that the new roads projected by the states individually, will form a coordinated interstate network.

SOCIETY CALENDAR

AMERICAN ASSOCIATION OF ENGINEERS, annual meeting, Chicago, Ill., Oct. 3-6, 1933.

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, annual meeting, Milwaukee, Wis., Oct. 9-11.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION, annual meeting, Chicago, Oct. 17-21.

AMERICAN PUBLIC HEALTH ASSOCIATION, annual meeting, Indianapolis, Ind., Oct. 9-12.

AMERICAN SOCIETY OF MUNICIPAL ENGINEERS, annual meeting, Milwaukee, Wis., Sept. 25-27.

AMERICAN WELDING SOCIETY, fall meeting, Detroit, Mich., Oct. 2-6.

HIGHWAY RESEARCH BOARD, National Research Council, Washington, D. C., Dec. 7-8.

INTERNATIONAL ASSOCIATION OF PUBLIC WORKS OFFICIALS, annual meeting, Milwaukee, Wis., Sept. 21-23.

INTERNATIONAL CITY MANAGERS ASSOCIATION, annual conference, International House, Chicago, Sept. 18-20.

NATIONAL SAFETY COUNCIL, 22nd Annual Safety Congress, Chicago, Oct. 2-6.

NATIONAL ASSOCIATION OF RAILWAY AND UTILITIES COMMISSIONERS, annual meeting, Cincinnati, Ohio, Oct. 10-12.

NEW ENGLAND WATER WORKS ASSOCIATION, annual convention, Bridgeport, Conn., Sept. 19-22.

School Rebuilding in Pasadena To Involve $1,500,000

About $1,500,000 will be required to remodel or rebuild school buildings in Pasadena, Calif., to make the construction comply with the earthquake resistant standards set forth in the California state law passed after the March 10 earthquake, according to an estimate based on indications contained in preliminary reports of a recent survey. School officials are endeavoring to determine whether the amount needed should be raised by a bond issue or by tax funds over a period of years.

Rockefeller Offers Palisades Parkway Land

John D. Rockefeller, Jr., has offered to contribute for a parkway 265 acres of land valued at $5,000,000 extending in a strip along the top of the New Jersey Palisades north of the George Washington Bridge at New York. Mr. Rockefeller has assembled the land over a period of years, in an endeavor to assist the Palisades Interstate Park Commission in its effort to preserve the Hudson River cliffs from defacement and commercial development. His offer at the present time is conditioned upon the ability of the commission to obtain within a reasonable time sufficient funds to commence the construction of the proposed parkway (from the George Washington Bridge some 13 miles north to the New York state line) and thereafter to continue and complete its construction. It is estimated that about $3,500,000 would be required for construction and additional amounts for the purchase of land not now controlled. About 20 per cent of the necessary land is still in private hands. Mr. Rockefeller's holdings aggregate about 40 per cent and the remaining 40 per cent is controlled by the park commission. The land required comprises an irregularly shaped strip running inland from the cliffs a distance varying from 300 to 1,000 ft.

Caves at Cove Creek Dam Site To Be Surveyed

A survey to determine whether the location of the Cove Creek Dam will have to be changed because of the great number of caves found close to the site has been ordered by Arthur E. Morgan, Chairman of the Tennessee Valley Authority. The survey, Mr. Morgan said, is likely to delay construction work.

Army engineers previously had reported many caves, Mr. Morgan has stated, but the number found has greatly exceeded those reported. He said, however, that it might be found that the change would not invalidate the plans already made.

New Scenic Highway Opened In Glacier National Park

The Going-to-the-Sun Highway, in Glacier National Park, a great scenic road project begun more than a decade ago and built at the cost of over two million dollars, was formally open on July 15. The dedication ceremony was held at the summit of Logan Pass where the new road crosses the Rocky Mountains to connect the east and west sides of the park.

Until the highway was completed, it was impossible to cross the park except by trail without going outside its boundaries. It is now possible for a transcontinental traveler going by the northern route to leave his railroad train at the park boundary, travel by bus across the reservation, and resume his journey the next day at the opposite boundary.

Because of the shortness of the construction season in that part of the country, nearly eight years were required to complete the road. The primary consideration in the selection of the route was the scenic possibilities afforded, with ease of construction being given secondary consideration. Consequently retaining walls often had to be built to provide protection for workmen and tunnels were driven through solid rock. Held by ropes fastened about their waists, men often worked on sheer rock walls a thousand feet high.

A scenic feature of the project is a tunnel in which a jagged window has been cut to afford a great panorama of the park's finest scenery.

Long Island Parkways Opened to Traffic

Two new units of the parkway system being developed by the Long Island State Park Commission were opened to traffic on July 15. These two units, which join at the city line, have a total length of 12 miles, extending from Queens Boulevard, Kew Gardens, eastward. The portion within the city limits in Queens Borough is known as Grand Central Parkway, and that in Nassau County as Northern State Parkway. The entire project was built by the Long Island State Park Commission but the Queens portion will be turned over to the city for maintenance. The city provided the land for this portion, but all construction expense was borne by the state.

Work is under way on the Interborough Parkway connecting Grand Central Parkway with Brooklyn, and it is planned that work on the extension of Grand Central Parkway to the Triborough Bridge over

Hell Gate, in the East River will get under way in the near future.

The parkways opened last week provide a 44-ft. concrete roadway, with service roads on either side, separated from the main parkway by 100 ft. of landscaped area. Grades for the most part do not exceed 2 per cent and the maximum is 3½ per cent. There are no grade crossings. A series of three articles describing these parkways was published in *Engineering News-Record* beginning February 16, 1933, page 209.

Personal Notes

R. L. McCormick, professor at Rose Polytechnic Institute, is one of the incorporators of the McCormick-Paige Engineering Corporation of Terre Haute, Ind., formed to engage in general construction and engineering.

James H. Bonner, civil engineer and independent oil operator, has been named city manager of Long Beach, Calif., by vote of the city council. Mr. Bonner is head of the D'Angelo Oil Company, which he developed. He came to California from Montana, where he was chief engineer of the public service commission.

Arno B. Cammerer has been named director of the National Park Service to succeed Horace M. Albright who has resigned effective August 9. Mr. Cammerer has been assistant director of the Park Service since 1919, before which time he was actively identified with the government building and parkways development program in Washington.

George E. Barnes, of New York City, has been appointed Professor of Hydraulic and Sanitary Engineering at Case School of Applied Science, Cleveland, Ohio. Professor Barnes graduated from Massachusetts Institute of Technology in 1923. In 1924 he became an instructor in the civil engineering department at the University of Florida, becoming in turn assistant and then associate professor. In 1929 he became a designing engineer with Fuller and McClintock, New York City, and then joined the engineering staff of the department of sanitation of New York City.

Obituary

Lewis E. Shepherd, pioneer engineering contractor, died in Denver, Colo., on July 10, age 70.

Frederick R. Charles, 64 years old, a former city engineer of Richmond, Ind., died recently at his home in Pittsburgh, Pa.

Arthur J. Walker, contracting engineer of Denver, Colo., died on July 4 at the age of 78. Mr. Walker was a native of Birmingham, England.

Charles F. Rowell, 77, veteran surveyor of Redfield, N. Y., died at his home in that village on July 13. He had spent a lifetime in surveying work especially in the Adirondack regions.

Arthur Ewing Roberts, Jr., aged 36, resident engineer for the Ohio highway department for Jackson and Pike counties was instantly killed when the car he was driving near Piketon, O., was overturned.

George B. Herrin, chief structural engineer for the Alcoa Ore Company, East St. Louis, Ill., died of a heart attack on July 7. Mr. Herrin was 51 years old and had been in the employ of the company for six years.

Joseph J. Feist, president of the John Feist Construction Corporation, Buffalo, N. Y., died at his home in that city July 14. Mr. Feist was born in Buffalo, July 28, 1874. He was president of the Builders Exchange of Buffalo from 1922 to 1926 and a past president of the New York State Association of Builders. He also was a past grand knight of Council No. 184, Knights of Columbus. He is survived by a widow and two daughters.

Charles A. Mullen, consulting paving engineer with the Milton Hersey Company, Ltd., Montreal, P.Q., lost his life on July 13 as a result of a fall from a sixth story window in the local Y.M.C.A., where he had been temporarily living. He was 40 years of age and had been associated with the Hersey organization for the past 17 years.

Charles H. West, formerly Chief Engineer of the Board of Mississippi Levee Commissioners, and member of the Mississippi River Commission, died on June 7 at his home at Greenville, Mississippi, at the age of 75. After studying civil engineering at the University of Illinois, Mr. West was engaged for many years in work on the Mississippi River, both under the Mississippi River Commission and under the levee boards. In 1898 he was elected Chief Engineer of the Board of Mississippi Levee Commissioners and was appointed a member of the Mississippi Commission in December, 1909.

David Arnold Starbuck, retired captain of engineers, United States Army, died suddenly July 9 at his home at Sierra Madre, Calif. He was 59 years of age. His death was caused by a heart attack. Captain Starbuck served one year as district engineer for the United States Army at Orleans, France, fourteen months in the Philippines during the Spanish-American War and five years with General Goethals during the building of the Panama Canal. In the recent Tacna-Arica boundary dispute in Chile, Captain Starbuck was a member of the United States commission. In California, Captain Starbuck engaged in engineering work in Los Angeles and was city manager and city engineer at Holtville, Calif.

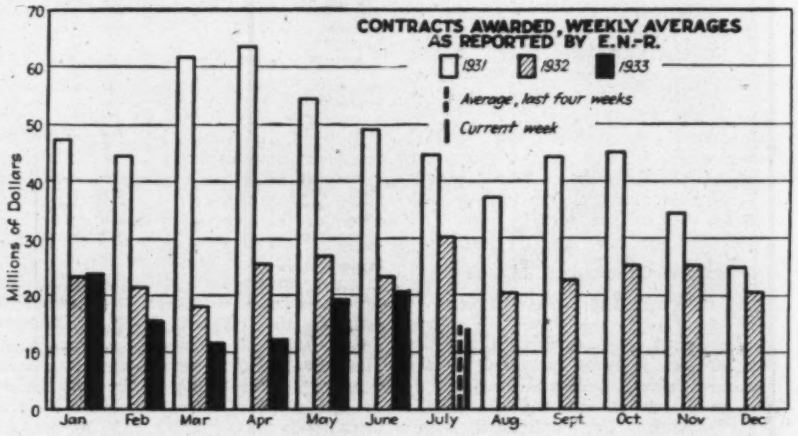
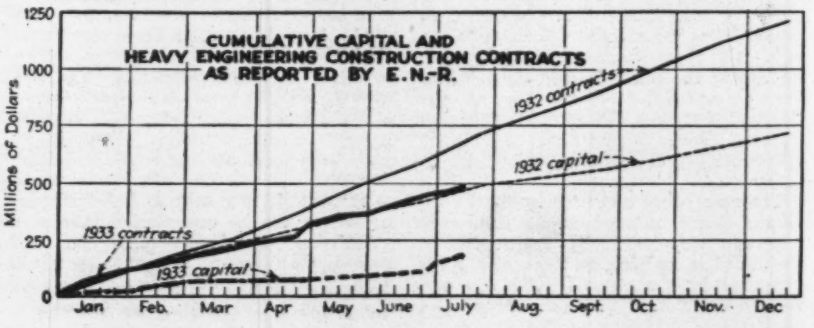
Contracts and Capital

CONSTRUCTION
(Thousands of Dollars)

	Weekly July 1932	Average Four Weeks	Week July 20 1933
Federal Government..	$11,176	$666	$217
State and municipal..	11,949	7,043	7,444
Total public.....	$23,125	$7,709	$7,661
Total private.....	6,989	7,438	6,402
Week's total.....	$30,114	$15,147	$14,063
Cumulative to date:			
1932.....		$688,458	
1933.....		483,080	

NEW PRODUCTIVE CAPITAL
(Thousands of Dollars)

	Weekly July 1932	Average Four Weeks	Week July 15 1933
New capital issues....	$19,000	$9,913	$3,797
Cumulative to date:			
1932.....		$458,000	
1933.....		175,250	

ENR Cost and Volume Index

E.N.-R. Cost		E.N.-R. Volume	
July, 1933.....	185.50	June, 1933.....	100
June, 1933.....	163.41	May, 1933.....	103
July, 1932.....	153.36	June, 1932.....	131
1932 (Average)..	156.97	1932 (Average)....	127
1931 (Average)..	181.35	1931 (Average)....	220
1930 (Average)..	202.35	1930 (Average)....	260
1913 Average.....	100